SOUTH AUSTRALIA.

# REPORTS ON ARLTUNGA GOLD FIELD AND HART'S RANGE MICA FIELD;

AND

## Explorations North-East of Hart's Range, North-West of Alice Springs, and of the Frew River Country, &c.,

*By H. Y. L. BROWN, Government Geologist.*

ALSO,

# CONTRIBUTIONS TO THE PALÆONTOLOGY OF SOUTH AUSTRALIA,

no. 9-10

*By R. ETHERIDGE. Junr.*

WITH MAPS, SECTION, AND PLATE.

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SOUTH AUSTRALIA.

# REPORTS ON ARLTUNGA GOLDFIELD, ETC.

REPORTS on ARLTUNGA GOLD FIELD and HART'S RANGE MICA FIELD and EXPLORATIONS NORTH-EAST of HART'S RANGE, NORTH-WEST of ALICE SPRINGS, and of the FREW RIVER COUNTRY, &c., by H. Y. L. BROWN, Government Geologist, with GEOLOGICAL MAPS and ONE GEOLOGICAL SECTION; and also APPENDIX by Mr. R. ETHERIDGE, Junr., being CONTRIBUTIONS to the PALÆONTOLOGY of SOUTH AUSTRALIA, ILLUSTRATED by ONE PLATE.

No. 1353.] Government Geologist's Department, South Australia, Adelaide, October 31st, 1896.

Sir—I have the honor to submit reports on my late geological explorations in the Northern Territory of South Australia.

In accordance with the instructions conveyed in your letter of March 31st, 1896, I left Adelaide on April 3rd and proceeded to Alice Springs, from which place I made the following journeys, viz. :—

1st. A visit of inspection to the Arltunga goldfield to ascertain the condition of the gold-mining industry, and whether it was advisable to erect a public crushing and cyaniding plant to extract the gold from the auriferous stone.

2nd. A visit of inspection to the mica fields in the Hart Range.

3rd. An exploration to country lying north-eastward of the Hart Range beyond the Plenty and Marshall rivers.

4th. An exploration north-westward of Alice Springs to country lying south-westward of Barrow Creek.

5th. A journey to Frew River and Elkedra county lying eastward and north-eastward of Barrow Creek Telegraph Station.

On the completion of this last journey I returned to Barrow Creek and from thence to Adelaide, where I arrived on August 13th, 1896.

Geological sketch maps of the several areas and routes referred to are appended to each report, and a general geological section is given from the Osborne Range, north of Barrow Creek, through Alice Springs and Charlotte Waters to Oodnadatta, showing the relative positions of the rock formations.

Some official contributions to the palæontology of South Australia, by Mr. R. Etheridge, junior, Curator of the Australian Museum, Sydney, are appended.

These relate to the carboniferous fossils collected by me at Fossil Head on the coast a few miles south-east of Treachery Bay, in the Northern Territory, and to a Trilobite discovered by me near Alexandra Station, on the tableland country of the Northern Territory.

A preliminary report on these fossils, by Mr. Etheridge, was published in an appendix to my Report on Geological Explorations in the Northern Territory, July 31st, 1895.

H. Y. L. BROWN, Government Geologist.

The Honorable the Minister Controlling the Northern Territory.



VISIT

## VISIT OF INSPECTION TO THE ARLTUNGA GOLD FIELD (MAP No. 1).

Leaving Alice Springs on the 27th April, I reached Arltunga on the 30th. A description of the rock formation along the route is given in my report of 1889. On this latter occasion I ascended Mount Benstead, a hill rising 1,325ft. above the general level; it consists of quartzite, quartzose sandstone, and grit, sometimes containing pebbles and occasionally intersected by thin quartz veins. The beds dip south at a high angle beneath beds of crystalline dolomitic limestone and slate, which are apparently conformable. Southward the limestone beds dip beneath another band of quartzite. Near and beyond Bitter Spring the limestone dips and disappears beneath massive hills of quartzite. Schistose and slaty granitic rocks then come to the surface and continue to Arltunga. These are traversed by quartz reefs, and are overlaid by quartzite and sandstone on the higher parts of the ranges.

### ALLUVIAL DIGGINGS.

The alluvial diggings are confined almost altogether to the same gullies and creek flats from which gold was being obtained at the time of my visit in 1890, no increased area having been opened up since. The number of diggers is not more than twenty-five, and none were working outside a radius of three miles of the camp. Although water is used when available for washing out the gold, it is not now considered essential, most of the men using dry blowing machines, which they consider more economical, being content to lose gold and save the heavy expense of carting the washdirt to water. One result of the dry-blowing method of gold extraction is that only the loose gravel, shingle, sand, &c., from near the surface is treated, the damp clay between the boulders and bottom rock, which should contain the coarsest gold, being left unworked.

A little alluvial work has been done in the gullies on the Claraville side, where the quartz reefs outcrop, and at Star Creek, but has now been discontinued.

No deep sinking has been undertaken for alluvial gold, and the river flats of the Hale still remain untested. In an auriferous country like this gold should be tried for in the deep ground; the depth of sinking would be from 30ft. to 40ft.

The Arltunga well and Star of the North well, and Claraville well all continue to yield supplies of good water, and the former supports, besides the population, a large number of horses and other stock. There is also water in the large rockholes and creek waterholes.

### AURIFEROUS REEFS.

Outcrops of quartz, containing gold, occur in the vicinity of Arltunga, but the principal and most numerous reefs are on the Hale river watershed to the north and north-eastward along a strip of country lying between Arltunga and Claraville; the distance between these places is eight miles.

In my report of 1890 a descriptive list is given of twenty-six reef localities, at most of which gold was visible in the quartz and gossan composing the veins. Since that time, except in rare instances, no work has been done to develop them.

It is not necessary to repeat this list; I will therefore confine myself principally to a description of the additional reef localities visited.

*The Macdonnell Range Reef* is situated about two miles north of Arltunga well, on the south side of a range; it dips northward at an angle of 10° to 15°, and strikes E. and W. At the southern outcrop, which is about 50ft. long, there are two or three quartz veins 1ft. 6in., 6in., and 3in. thick respectively, separated by decomposed gneissic, micaceous, and argillaceous rock, resting on black argillaceous slate as a footwall.

Going northward three or four shafts have been sunk which (as the surface conforms in dip to the reef) have cut it at 10 or 12ft., and exposed two quartz reefs ranging in thickness from 2ft. to a few inches, separated by a band of mullock, and having black plumbagenous slate beneath. The quartz has been stoped out round these shafts to a small extent. Some 75yds. N.E., what may be the same, but is apparently an overlying reef, dips at an angle of 30° to 35° N. into a steep hill, beneath argillaceous and micaceous gneissic schist, the footwall being black argillaceous micaceous slate. The quartz is 2ft. thick at this place.

Copper ore (oxide) is associated with the quartz, and at the southern outcrop it is in bunches which can be easily picked out from the quartz, and contains gold. Two hundred and ten tons of quartz treated at the Huntingdon mill returned 163ozs. of gold. (Luce.) Specimens containing visible gold have been often found. The veins of quartz being interstratified between different kinds of rock it seems probable that by sinking deeper other veins may be found beneath.

The shoot of quartz is short at the outcrop, but may extend further along the strike when followed down; as it is, a considerable quantity of vein stuff could be raised. Two auriferous gullies commence close to this outcrop.

Other large quartz outcrops occur a short distance westward and eastward, dipping in the same northerly direction.

*Great Wonder Reef.*—Locality, Kimberley Gully, about one mile E.S.E. from Star of the North well. This is a short outcrop or blow of quartz with granitic schist and calcareous veins, 4ft. to 6ft. wide, striking E. and W. and dipping N. at 50°.

It has been worked down to about 15ft. The quartz is stained with carbonate of copper, and contains also oxide of copper and pyrites.

Sixty tons crushed yielded at the Huntingdon mill 30ozs. 10dwts. of gold.

*The Christmas Reef* is situated about fifteen chains south of the Macdonnell Ranges reef; it crosses an auriferous gully which starts from the last-named reef. It strikes E. and W. and dips 80° S. and vertically, cutting through micaceous sandstone and granitic schistose strata. The vein is small, and not traceable far along the surface; 3 tons averaged 15dwt. of gold per ton after 6ozs. of coarse gold had been picked out. (Messir.)

Nuggets to the weight of 3ozs. 25dwts., 3dwts., and 7dwts. were found in the gully when worked. (Messir.)

Half a mile east of this place small veins of brown iron oxide and quartz occur in coarse gneissic granite, argillaceous slate, granite, and hornblendic granite. They are rather numerous, and often show gold. These small veins are probably one of the sources of the alluvial gold which is found on this field on rising ground and where there is no apparent reef outcrop.

*The*

*The Victory Reef* is about half a mile from Arltunga well; it strikes north-easterly and dips north-westerly, and consists, where opened up to 8ft., of quartz 2ft. thick and leaders in the hanging wall. The surface quartz outcrop is about 60yds. long, reaching a width of 3ft. or 4ft. in places. The quartz is copper stained and contains carbonate of iron. No crushings have been tried.

*The Albion* is a reef of quartz one and a half chains long and 4ft. to 5ft. thick, with leaders cutting through schistose gneissic and slaty strata. Ten tons crushed yielded 7ozs. of gold. In this neighborhood there are numerous other quartz reefs and leaders, in some of which gold has been observed. The gullies and flats traversing the ranges here are as yet untried, although very favorable to the occurrence of alluvial gold.

*Round Hill Reef.*—A quartz, ironstone and pyrites vein up to 10in. wide, striking N.E. and dipping S.E. and also vertically. It has been worked by a cutting some 10ft. deep and two chains long. There are other parallel auriferous veins in the near vicinity. All the veins cut across and through the strata, they range in thickness from 10in. to 2in.; the quartz is cellular and gossany; gold is frequently visible in the stone. The walls of these veins are straight, and apparently due to faults traversing the strata, which consist of gneissic granitic flaggy sandstone and argillaceous, micaceous, and chloritic schists.

*The Lone Hand.*—A very small but rich vein of quartz with carbonate and oxide of iron, which has been worked to a depth of 4ft. to 6ft. for a distance of four or five chains along the surface, on a strike of N. 10° E., through micaceous granitic sandstone. Rich specimens of gold have been obtained from the vein, which most probably will be traced to greater depth when further prospected. While being worked the gold was, I am informed, dollied out by hand.

*The Wipe Out.*—This reef has been worked by an open cut two and a half chains along the strike (N. 15° E.) to a depth of 30ft. The veinstone is white quartz, stained with copper carbonate. It cuts through gneissic micaceous granite, and dips vertically and westward. Water is met with at 30ft. There are numerous other quartz and gossan reefs in the neighborhood, most of which have an E. and W. strike.

*The Claraville and Wheal Fortune Reefs* are in the same condition as described in my report of 1890, little or no additional work having been done.

*The Beehive Reef* is being worked by an open cut 30yds. long and 20ft. deep along a strike of N. 10° E. It is associated with diorite and greenish jointed syenite with felspathic veins. The rock is gneissic micaceous granite and gneissic syenite. The reef is small and splits into veins in places. It has well-defined walls cutting vertically through the strata.

Some fourteen miles in a south-easterly direction from Claraville, near the head of Star Creek, a little prospecting work is being done at *Russel's Reef.* Here there are veins of quartz and ironstone, more or less copper-stained, ranging in width from a few inches to a foot, and cutting through the strata more or less vertically. They vary in strike from N. and S. to 10° N. and 20° W. Fine gold is frequently visible in them.

Near the same locality there are several of these auriferous veins lying parallel to one another at short distances apart. Alluvial gold has been worked here and at Star Creek. The Duffer, Orient, and other quartz reefs have been worked to a small extent.

The shoots of quartz in all these reefs are generally short and the reef narrow; still they are numerous, and so far, as tried by crushing, have yielded fair returns of gold. No shaft has been sunk more than 50ft., and none of the reefs have been worked by drives from the bottoms of shafts but only by underhand stoping or quarrying, which is a most expensive and unsatisfactory manner of working small reefs. I have no doubt but that, as mentioned in a former report, a large quantity of quartz could be raised without difficulty if machinery were available to treat it at a reasonable cost.

I therefore recommend the erection of a battery of not less than ten stamps, with copper plates and blanket tables or Frue vanners, and a small cyanide plant for treating tailings. Both copper ores and iron pyrites occur in most of the quartz reefs and galena in some; for this reason some concentrating apparatus is required, a Frue vanner being, I think, the most suitable. When at Claraville I smelted some of the heavy concentrates from the Huntingdon mill and obtained an alloy of lead and copper, chiefly the former, which on assay by the Government Assayer returned gold at the rate of 69ozs. 8dwts. and silver 126ozs. 12dwts. per ton.

The gold occurring in the stone is fine and, in many cases, scaly, and a percentage must, as a matter of course, be carried away in the slimes and tailings, which gold will be recovered by the cyanide process.

The following are assays of three rough average samples taken by me from the tailings heap:—

| | | |
|---|---|---|
| No. 1 | Gold, 5 dwts. per ton; | Silver, 7 dwts. per ton. |
| No. 2 | " 2 " " | " 10 " " |
| No. 3 | " 3 " " | " 7 " " |

Three samples of heavy sand, concentrates probably obtained in washing off the mill, returned as follows:—

| | | |
|---|---|---|
| No. 1 | Gold, 6 ozs. 4 dwts. per ton; | Silver, 48 ozs. 7 dwts. per ton. |
| No. 2 | " 3 " 0 " " | " 2 " 6 " " |
| No. 3 | " 0 " 15 " " | " 2 " 2 " " |

I was unable to obtain any average sample of the slimes from the mill, as these run into the river, become mixed up with the sand, and are afterwards removed by floods.

As a site for the proposed quartz battery I would recommend a position about one mile south of Claraville, where there is a suitable rise. In this case a well would have to be sunk to supply the plant with water; by sinking on the line of several large parallel quartz reefs at this place to a depth of about 100ft. and driving across them, I believe, sufficient water would be obtained, or water could be pumped from the Claraville well. As an alternative, there is a good site for a large tank on a swamp or flat about half a mile north of Claraville, provided trial holes when sunk prove the ground to be sufficiently clayey to hold water. There is also rising ground in the neighborhood on which the battery could be placed.

The Government well, on the river flat, within a few yards of the Hale, is liable to be flooded when the Hale runs, and, besides, here the ground is level and sufficient fall cannot be obtained for the tailings, so that, as a site for a battery, it is unsuitable. Since the great floods on the Hale a few years ago it has continued to yield a supply of water sufficient for the requirements of the Huntingdon mill. This well has, however, fallen in, and requires re-timbering.

The

The following list of the prineipal reefs, from which stone has been raised and treated at the Huntingdon mill, together with the yields of gold, has been furnished me by Mr. Luce, the proprietor of the mill:—

| Name of Reef. | Tons Crushed. | Gold Yield. | | Name of Reef. | Tons Crushed. | Gold Yield. | |
|---|---|---|---|---|---|---|---|
| | | Ozs. | Dwts. | | | Ozs. | Dwts. |
| Macdonnell Range | 210 | 163 | 0 | Wheal Wonder | 6 | 6 | 0 |
| Star of North | 5 | 5 | 0 | Standard | 12 | 8 | 0 |
| Great Wonder | 60 | 30 | 10 | Roundhill | 58 | 33 | 12 |
| Albion | 10 | 7 | 0 | Florence | 15 | 12 | 15 |
| Redemption | 47 | 56 | 0 | Duffer | 40 | 40 | 0 |
| Orient | 17 | 17 | 0 | Wife Out | 87 | 67 | 0 |
| No Name | 10 | 2 | 5 | Claraville | 100 | *200 | 0 |
| Beehive | 110 | 77 | 0 | Wheal Fortune | No record | — | |
| Russels | 15 | 5 | 5 | | | | |

* The bullion from the Claraville Reef assayed one-third gold and two-thirds silver.

Several tons of stone from the Wheal Fortune Reef have been erushed from time to time, the average yield being about 17dwts. The value of the reef gold generally is from £3 10s. to £3 12s. per ounce.

I am unable to make an estimate of the quantity of quartz likely to be available for crushing, none of the mines having yet been opened up sufficiently to enable me to give a deeided opinion; the reefs up to the present have only been sunk on to a depth of 50ft., and that only in one instance. I believe, however, that sufficient stone ean be raised from the localities already known to keep a battery of ten head of stamps at work for some years.

## THE MICA FIELDS (MAP No. 1).

From Claraville to the mica fields in Hart's Range there are two or three routes, by one of which drays can travel, the others being only suitable for pack-horses or camels. These tracks pass through rough ranges and up the sandy beds and through the gorges of winding creeks. The track I used in going out crosses the Tug Creek at Red Bar, six miles from Claraville, enters the ranges at seven miles, and again crosses the Tug at fifteen miles, which creek it follows up to a divide at twenty miles. Crossing this divide it follows down the creeks, which then run N.W. to Stone well, where there is a gorge in the hills, and emerges on to the plains on the north side of Hart's Range at a distance of about thirty miles from Claraville. In a direct line the distance is eonsiderably less, the rough nature of the country making a circuitous route necessary.

The prineipal mica localities are on the northern watershed of Hart's Range, east and west of Mount Palmer, in the vicinity of which hill are the most important finds yet known.

At the time of my visit only one mine was being worked. It is known as Oolgarinna, or Chambers' Mine, and is situated on the side of the mountain, near Mount Palmer, at a height of about 1,000ft. above the plain and 700ft. below the top of that hill. It is distant from Mount Brassey, the highest or one of the highest points of the Hart Range, three miles in a north-westerly direetion.

The workings eonsist of an open cut or quarry on a large composite dyke of felspar, quartz, and miea. The felspar is in large and solid masses, sometimes containing a little quartz and small mica erystals—the quartz is in masses with irregular veins in the felspar, and the mica is in small scales and plates of two to three square inches in the quartz and felspar. The whole dyke penetrates and underlies a micaceous schistose rock, which is chiefly mica, and extends westward for a distance of some three ehains with a width of one chain. The large plates of mica are obtained from bunches or blocks abutting against the quartz at its junction with the felspar, and at the junction of the felspar and quartz with the main mass of micaceous granite rock and detached portions of the same, whieh have beeome enclosed in the dyke.

Mr. Chambers informs me that the largest block of mica found in this mine measured 6ft. x 5ft. x 4ft., and that 7cwt. of cut mica were obtained from it, and that these blocks generally occur on the hanging wall of the bedrock, with shoots into the quartz and felspar dyke.

The oecurrence of the mica blocks is irregular, but so long as the dyke continues, blocks of mica may be expected to be found by following it downwards or along the strike.

The mica is split, cut, and sorted on the ground, and plates up to 12in. x 14in. are obtained.

This quarry or cuttting has been worked down to a depth of some 10ft. or 15ft., and the dyke continues underfoot, and is of the same eharacter as at the surfaee; it is therefore to be expeeted that a eonsiderable quantity of mica still remains to be excavated.

Pope's Claim, The Disputed, Mullen's, Williams', Gall's, and other mica claims are in the immediate neighborhood of Mount Palmer.

*Pope's Claim.*—This dyke formation trends E. and W.; a large mass of quartz forms the north wall, joining which on the south side is felspar associated with quartz and mica blocks. This is bounded by hornblendie gneissie granite and micaceous granite, containing a coarse granite dyke (quartz and felspar), and also a dyke of diorite having a porphyritic structure.

The workable mica blocks occur along the line of junction of the felspar and quartz masses, and also in the coarse granite dyke. The amount of excavation done is comparatively small, but 10cwt. of cut mica are said to have been taken out. Blocks of mica are visible in places along the outcrop.

*The Disputed Claim.*—The workings here are on a coarse granite dyke (felspar quartz and mica), whicl has been intruded into a gneissic, micaeeous, and hornblendic granite, sometimes porphyritie. A drive has been put in about 50ft. along the hanging wall, and 6ft. or 8ft. of dyke removed, in which the blocks of workable miea oeeur; these are still showing in the rock faces. The width of this dyke is some 4 chains or 5 chains, and it strikes W. 10° N., and dips S. The amount of quarrying done is eomparatively small.

*Mullen's Claim.*—The formation here is a coarse granite with massive felspar and quartz. The dyke is about 20ft. wide, and the mica blocks are scattered through the felspar and quartz masses. The dyke strikes N. 10° W. through green gneissic syenite. Two tons of rough mica are said to have been raised. Very little quarrying has been done.

*Williams'*

*Williams' Claim.*—The mica occurs in a felspar and quartz dyke. One ton of rough mica of a superior quality is said to have been raised. Very little excavation has been done.

*Gall's Claim.*—A dyke composed of massive felspar and quartz and coarse granite (felspar and quartz) is the matrix of the mica, which is scattered through the dyke mass, which has a width of some 20yds.

Black mica, as well as the ordinary smoky variety, is obtained. Twenty-seven hundredweights of rough mica are said to have been raised. Only a small amount of excavation has been done.

At Mount Palmer, which is the centre of the above-mentioned mica localities, the country rock consists of felspathic gneissic granite and gneissic granite, dipping N.E., syenite, porphyritic gneissic and compact, also dipping N.E. Diorite and quartz diorite occur as dykes, as also do coarse granite (felspar and quartz) and massive felspar. These are almost always associated with large massive veins, or blows, of quartz; together they form the mica-bearing outcrops.

In viewing the ranges from the top of Mount Palmer these mica-bearing dyke outcrops can be seen in numerous places, being distinguishable by their light color from the enclosing metamorphic rocks. Most of them show mica to a greater or less degree, and within a mile or two of this point there are several localities where mica has been obtained from them besides those I have mentioned. None of the localities, except that at Oolgarinna were being worked.

There are other localities which have been worked a few miles to the westward of Oolgarinna, viz.:—Stone's, Thompson's, Lloyd's, and others.

*Stone's Claim.*—An irregular-shaped intrusive mass of very coarse granite, with dykes of felspar and sometimes quartz, develops mica in and at the junction with the metamorphic micaceous granite, mica schist, and gneiss at this place. A considerable amount of excavation has been done here to a shallow depth, and a shaft some 25ft. deep has been sunk at one point. Red garnets in flattened crystals occasionally occur in the sheets of mica.

*Thompson's Claim* is on a dyke of coarse granite, with massive felspar and quartz. The mica, which occurs in the quartz and granite, has often twisted or bent planes and is split into thin schistose plates. Magnetic iron ore occurs here.

*Lloyd's Claim* is on a dyke of felspar and granite, with masses or blocks of quartz. The mica blocks are in the felspar and quartz.

Eastward along the Hart Range for several miles similar dyke outcrops occur, some of which have been worked to a greater or less extent for mica. Wherever these coarse granite dykes with massive felspar and quartz in reefs or blocks occur; there, in addition to the ordinary small crystals of mica forming a constituent part of the granite, whether eruptive or gneissic, mica blocks of greater or less size are found, and the dykes when quarried often yield mica of sufficient size to be of economic value. These dykes are always in some degree irregular in shape and size, branching out and widening or contracting and thinning out as sunk on. The occurrence of mica in them is also irregular and uncertain. Mining, therefore, for mica is necessarily an exploration of these dyke masses, and a search for blocks and patches of sufficient size to render them of value. Small blocks may only be met with, or large bunches may be discovered as work progresses, there being no certainty in the matter.

At the present the dykes are worked down from above or quarried, and the work is done gradually, a small quantity of rock being blasted out each time. This method could be, I have no doubt, greatly improved upon if shafts and drives were made in the neighborhood of the mica-bearing dyke and large quantities of rock upheaved at one time by the employment of explosives on a large scale.

The number of mica-bearing dykes is large, and they extend over a large area. Although most frequent in the neighborhood just described they occur in other parts of the Hart Ranges. The work done hitherto in most cases is confined to shallow excavations near the surface, from which a few hundredweights or tons, as it may be, of mica have been procured. The industry is one which requires capital, as not only is the mining for the mineral difficult, but after raising it has to be split, cut into sizes, and sorted—a process which requires the presence of an expert in mica. Even when this has been done there is no certainty as to the price that will be obtained for it. It is, therefore, not an industry which can be profitably undertaken by the individual miner without capital. With regard to the future of mica fields I believe that there is here a large field for the employment of capital by those who understand the business, as from the numerous mica-bearing outcrops a large quantity of mica can be raised. The following minerals are found with mica in these mines:—

Tourmaline—In flattened crystals.
Beryl—Flattened and also in hexagonal crystals.
Garnets—Flattened plates and in the usual perfect crystalline shapes.
Quartz—In flat layers resembling thin glass and white lace-like sheets between the plates of mica.

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## EXPLORATIONS NORTH-EASTWARD TO COUNTRY BEYOND THE PLENTY AND MARSHALL RIVERS, AND RETURN TO CLARAVILLE (MAP No. 2).

Leaving Oolgarinna on the 11th of May, I proceeded to Lucc's Spring, passing a place known as Strathallan's Camp at six and a half miles. Here there is a tree marked:—

△S
Lat. 23° 1′ 17″
Lon. 8° 59′ 55″

1,584ft. above sea.

At nine miles reached Lucc's Spring, which is situated about a mile up a deep gorge in the ranges. There are numerous east and west dykes of felspar and quartz, indicating the presence of mica (which has been worked to a small extent at several places) along the outside of, and in these ranges, which rise 1,000ft. or more above the general level. The rocks are gneissic granite and syenite containing garnets; they dip N.E. The felspar, quartz, and coarse granite dykes cut across and through these metamorphic rocks, and also conform to the strike of the latter.

May 12th.—Continued eastward over a well-grassed plain, with low hills, the main range lying a short distance to the right, for twenty-four miles, to Lindsay's Rockhole, crossing the Entia, or Undia, a large creek flowing north into the Plenty river, at fourteen miles. The rockhole lies in a gorge of the main range, and contained only a small quantity of water. The rocks here are less gneissic in structure than to the westward.

May 13th.—Followed a north-easterly course in the direction of Mount Sainthill, over grassy plains. At nine miles passed some low hills of brown jasper quartzite, containing veins of opalline quartz, chalcedony, and iron oxide, with a little prase or green quartz. Passed a table hill on left, the point of a low tableland, at eighteen miles, and crossed the Plenty river at twenty miles. The bed of the river is some 200yds. wide, and consists of deep sand. It is bordered on each side for some miles by plains covered with gydgea trees and sandy flats and rises, with mallee and spinifex, apparently all liable to floods. At twenty-seven miles reached some low gneiss and granite hills, bordered by grassy plains, and camped without water. At this place mica plates of small size occur in a coarse granite dyke, with quartz outcrops, striking E. and W. A little work has been done in trying to obtain mica, with, I believe, an unsatisfactory result. The place is called the Jim Crow Mica Mine.

May 14th.—Went northward four miles to the Marshall River, and followed it up one mile to a soakage in the sand bed of the river, which proved to be dry. Continued on northward, passing Mount Sainthill at three miles, and reached a group of rockholes full of water, named Oorobbra, at eight miles from the Marshall, and camped. The Marshall is bordered on each side by plains, with low hills of gneiss and granite, which are the prevailing bedrocks. At Oorobbra rounded rocky hills rise from 200ft. to 300ft. above the plain, and form portions of a range. About one square mile of these hills consists of bare rock, in the depressions of which numerous rockholes exist, which have been hollowed out of the solid rock by the action of water. Every depression or gully has its own system of rockholes, all of which at the time were full of rain water. The largest hole measures 24ft. x 15ft., with a depth of 5ft. to 6ft.; consequently contained about 7,000galls. of water. On the flat below, the gullies or small creeks also contained large pools of water. The rock formation here, which resembles ordinary granite in the contour of the hills and the shape of the large boulders lying about on them, is a metamorphic granitic grit, containing but little mica. Water-worn pebbles and boulders of quartz and quartzite syenite and granite occur imbedded in this rock. It appears to have been reconstructed from a previously-existing granite; in places it is porphyritic. From one boulder of quartz contained on this rock I obtained specimens of galena, which, on assay, yielded at the rate of 17dwts. of silver and 17 per cent. of lead per ton. As this granitic rock probably belongs to the oldest series of sedimentary rocks known in Australia, the occurrence of a quartz boulder containing galena indicates the existence of lodes containing metallic minerals in rocks of still greater geological age than this metamorphic granitic rock. It is overlaid in places by a thin bed of quartzite and conglomerate. Thin veins of baryta (sulphate of barium) are frequent in the granitic rock, and pebbles of the latter are plentiful in the gullies. I obtained a little galena by washing at one place, which mineral was probably derived from one of these baryta veins.

May 15th.—Proceeded eastward, passing a bluff at one mile, which I have marked Grant's Bluff on map. It rises 300ft., and is composed of quartzite and flaggy argillaceous sandstone on blue shale, dipping 15° S. off metamorphic granite. Two miles north-east of this place crossed a band of granite country with reefs of quartz and quartzite, rising in places from 20ft. to 50ft. above the surface, and extending north-westerly and E. and W. for a considerable distance. These reefs vary in thickness from 1ft. to 15ft. and 20ft., and are vertical, sometimes having a continuous outcrop half a mile or more in length. They are composed of a bluish quartzite rock and quartz with often gossan and ferruginous quartz. The band of country containing them is about six miles wide; and eight or ten of these large reefs were crossed in that distance. I was unable to detect any gold or other metallic mineral, except iron, in them, but believe them to be lode outcrops, and, therefore, worth prospecting, as also is the country in their neighborhood. This day I camped on Oolmoolmilla Creek, about one and a half miles below Oolmoolmilla Springs, where there is a waterhole 200yds. or 300yds. long. The springs are in hard blue limestone country, the strata being vertical. Rain having fallen over all this country, the creek had large waterholes for some distance below the springs. Near the camp the rock was red hornblendic granite and coarse granite overlaid by limestone, and containing veins of hard cherty limestone.

May 16th.—Proceeded down Oolmoolmilla Creek one mile to a large quartz lode in decomposed granite and followed it in an easterly direction nine miles to a hill (Mount Sandy), which is almost entirely composed of quartz and quartzite. From this point noticed two large reefs running E. and W. at distances of one mile and two miles. To the E. and S.E. are rough ranges with quartz reefs, to N.E. extensive tablelands of sandstone and quartzite, and to the N. vast plains.

From Mount Sandy went northwards four miles over plains with granite rises containing small quartz and quartzite reefs, crossing Oolmoolmilla Creek at three and a half miles, and ascending a bluff of quartzite and sandstone similar to Grant's Bluff; thence down the creek for five miles, having a steep sandstone table-land escarpment on the S. and limestone hills on the N. Camped at a waterhole in this creek near two low flat-topped sandstone hills surrounded by grassy plains. Oolmoolmilla Creek here has a deep sandy bed; it trends in a westerly direction through grassy plains and along the north side of sandstone tablelands and hills.

May 17th.—Examined the tableland to the S. and found it to consist of flat top and rounded ranges 400ft. to 500ft. above the plain composed of flat and inclined bed of sandstone and quartzite, with deep ravines, precipices, and ridges running E. and W. From the highest part a view of the country N. and N.E. showed vast plains with low rounded ranges on the horizon twenty to thirty miles off. The strata in this range are thrown into anticlinal arches in places and dip northward into the plain. Marked a tree at camp $\overset{B}{\uparrow}$ 17/5/96. Found a waterhole in a gorge bearing 158° N. about one mile from this camp.

May 18th.—From camp on Oolmoolmilla Creeek proceeded S.S.W. two miles round the western end of the sandstone range or tableland; thence S.E. seven miles to a hill (Mount Mascott) composed of mica schist and micaceous clayslate with quartz veins containing tourmaline. Sandstone tableland and hills were visible to the E. and N.E. to the horizon. Southward the granitic country with quartz reefs continues, apparently wedging out to the S.E., beyond which are plains. The mica slate country, which is dotted over with small quartz outcrops, forms rough rounded hills occupying an area of ten or twelve square miles round this hill. This rock formation is favorable to the occurrence of gold. In the creeks fragments of diorite, porphyry,

porphyry, &c., indicate the presence of igneous dykes in the rocks. The creek, flats, and gullies between the hills are well grassed, and some of the creeks contained a little water in the sand, due to late rains. Returned to Oolmoolmilla Creek by the same route, crossing it about four miles above the last camp (May 17th), and continued northward over crystalline dolomitic limestone to a branch creek coming in from N.N.W.; followed this creek up and camped without water. This limestone dips northerly, and underlies the sandstone and quartzite of the tablehills and tablelands; it often contains chert and flint in bands and lumps, and lithologically resembles the limestone occurring at Mount Benstead, Bitter Spring, and elsewhere in the Macdonnell Ranges.

May 19th.—Followed up the same creek W.N.W. four miles to an escarpment of sandstone underlaid by limestone, which latter forms low ranges below the escarpment; thence turned northward along the sandstone escarpment for three miles, and reached Arrinthrunga Spring. This spring is in a deep gorge in sandstone. The water extends some 300yds. or 400yds. up this gorge, and flows out at the entrance in a small stream into the Arrinthrunga Creek, which latter, passing over limestone country on to the plain, trends easterly into Oolmoolmilla Creek. From this place continued following round to the right of the sandstone escarpment over limestone country, crossing Grindstone Creek (of Chambers) at twelve miles, low tablehills and plains lying to the right. At fourteen miles crossed a small creek with a deep hole full of water, and at sixteen and a half miles Turkey Creek (of Chambers), where there is also a small waterhole, over grassy plains with sandstone and limestone rises. Camped at twenty-four miles under an escarpment of the same sandstone tableland. To the N. are low tablehills and plains extending to the horizon.

May 20th.—Proceeded N.W. still along the escarpment and over ranges and plains, crossing a large creek, Gum Creek (of Chambers), at four miles, in which there is a deep waterhole about three-quarters of a mile in length in sandstone just below where the creek leaves the sandstone hills and debouches on to the plains. At eight miles reached Ooratippra, another large creek coming out of the ranges and flowing northward, also containing a long and deep waterhole just below where it leaves a gorge. Noticed a tree marked $\begin{matrix} D & M \\ T & M \end{matrix}$ at this water.

Went from this waterhole southwards up Ooratippra Creek through rough sandstone gorges containing a chain of waterholes which necessitated crossing and re-crossing the creek several times in order to find a road smooth enough for the horses; after travelling for three hours made a distance of about five miles. Rocks all sandstone and quartzite in undulating and horizontal beds. Camped on a flat where a creek coming from the S.E. joins Ooratippra Creek.

May 21st.—Travelled S. and S.S.E. for four hours (about seven miles) up the creek through sandstone gorges and over large rocks and boulders, which strewed the bed of the creek, being unable to leave it owing to the existence of cliffs and terraces in the hills; thence S. and S.E. up the creek for four miles and ran the creek out into several branches coming from the quartzite and sandstone hills. Continued on southwards about two miles to the summit of the hills and came to precipices a few hundred yards on, which stopped any further progress in that direction. These precipices are overhanging in zigzag terraces one under the other, the total fall from the top to the plains below being some 600ft. or 800ft. They are in the neighborhood of Mount Ultim, a trig. station of Winnecke's. Being unable to descend the escarpment went eastward along it for about one mile and descended into a deeply-cut creek valley, which was reached by a steep slope, 200ft. below the summit. Followed this creek down three miles over very rough sandstone and quartzite country, with wide open cracks across the rocks similar to what might be caused by an earthquake, and camped in the creek, which is bordered on each side by steep cliffs of sandstone, calcareous sandstone, and limestone in horizontal and undulating beds. Small waterholes occur in the rocky bed of the creek.

May 22nd.—Continued down the same creek on a south-easterly, southerly, and easterly direction six miles to the junction with a large creek coming in from a ravine on the S.; thence two miles in a north-easterly direction, passing large creek waterholes at intervals all the distance. Continued following this creek, which turns northward, and, after travelling eight to ten miles further through a well-grassed valley and past long and deep waterholes bordered by sandstone and quartzite cliffs and bluffs, emerged on to the plains previously passed over in the vicinity of Chambers' Gum Creek, which, therefore, is the same as that followed by me from Mount Ultim Heights. Named this Mistake Creek.

May 23rd.—Returned round the sandstone tableland by the same route I had come out, and camped two miles W. of Arrinthrunga Spring. Distance travelled, eighteen miles.

May 24th.—From camp by outgoing track back to Oorobbra Rockholes. According to Mr. Chambers, who was the first to make a rough traverse of this country, the springs marked on the accompanying map are permanent, many of them containing fish. A short time previous to my visit this region had been favored by good rains, which had filled all waterholes in the creeks and at the springs. As the formation is sandstone and quartzite resting on limestone, I have no doubt but that those springs are permanent which have their origin in the limestone; those, however, which occur at a higher level in the overlying sandstone would, I believe, in times of long drought be likely to fail. The country outside of the sandstone ranges is good pastoral country.

I was unable to find any fossils in the sandstone or limestone formations, so that there is no evidence available as to their geological age.

The system of rockholes at Oorobbra contain in the aggregate a large quantity of water, and in ordinary seasons could be depended upon to last a considerable time. Oorobbra and the springs at Oolmoolmilla, Arrinthrunga, Ooratippra, &c., would be convenient places for depôts for the exploration and examination of the surrounding country.

May 25th.—Started from Oorobbra on return journey, travelling on a bearing of 230° (S. 50° W.) over grassy plains, with gneiss and granite hills and quartz reefs; crossed the Marshall at eight miles and a branch of the Marshall, or a separate creek at eleven miles. Camped at eighteen miles without water. The country passed over is chiefly well-grassed plains of red loam and sand, with occasional low gneiss and granite hills.

May 26th.—Five miles from camp crossed the Plenty river near the Plenty wells. The bed of the creek is sand about 200yds. wide, and there was no sign of water, which might, however, be obtainable by digging deeply into the sand. At eight miles passed a low tablehill range on the left composed of horizontal sandstone and quartzite. Common opal and flint stones are scattered over the surface here. All round are well-grassed plains of sand and loam.



At

At twenty miles reached the flank of Hart's Range, and changed course to westward along it for three miles; then entered the ranges and followed up Entia Creek through them, twelve miles to Entia water, and camped at thirty-four miles, the distance from the last water (Oorobbra) being fifty-two miles.

May 27th.—Travelled through rough rocky ranges of gneiss, granite, and syenite, with dykes of granite and quartz containing large mica, which had been mined at two or three places, to Oolgarinna. The track, which is very indistinct, winds about to avoid the hills, and ascends and descends the saddles of the ranges, which are elevated in some places 1,000ft. above it.

May 28th.—From Oolgarinna returned to Claraville by a track which crosses Hart's Range close to Mount Brassey at a height (barometrical) of 2,575ft. above sea level, Mount Brassey being about 1,000ft. higher. This track, after passing over a range near Mount Brassey, strikes the head of the Maude Creek, which it follows down to its junction with the Florence, after which it crosses over the Tug to Claraville; the total distance is thirty-one miles.

On this route two lines of ranges are crossed, viz., Mount Brassey Range and another parallel to it a short distance S.: these constitute Hart's Range. The rocks composing them are gneiss (both hornblendic and micaceous), gneissic granite, and syenite, and eruptive granite. Granular and crystalline limestone beds and metamorphic sandstone are interstratified. Near Oolgarinna these limestone beds are well developed, occurring in thick beds interstratified with the gneissic rocks; the dip of these rocks is N. and N.E. at various angles.

Southward of the Hart's Range and down the Maude granular limestone and quartzite and gneiss occur; also coarse porphyritic gneissic granite in horizontal and inclined beds as far as Muller's Camp on the Florence. Gneiss, granite, and diorite compose the ranges between this place and the Tug Creek. Garnets are plentiful in the gneissic and granitic rocks of the Hart's Range especially, being an almost invariable constituent of the rocks. Epidote and epidosite are also common.

May 30th.—Arrived at Claraville, and was engaged till June 2nd in examining the gold reefs in the neighborhood of that place and Arltunga, particulars of which are given in an earlier portion of this report. While in this neighborhood I visited Giles' Hole and South Gap, which are on the Arltunga Creek, fourteen and twenty-two miles respectively below Arltunga. At the first gorge passed through the rocks are quartzite and sandstone, dipping N. off limestone, gneissic schist, and argillaceous slate. Between this and the second gorge the creek, valley, and lower hills are composed of hornblendic granite or syenite, with argillaceous and micaceous schists, diorite, and occasional quartz reefs. Quartzite rock occupies the higher hills and ranges bounding the valley. At the second gorge the creek cuts through quartzite, striking E.N.E., and dipping 50° to 70° S., and is succeeded and overlaid by limestone, quartzite, and limestone, and slate beds in the order named, also dipping S.; this is followed by granite and gneiss and schistoze granitic rock with diorite. The creek has been worked to a small extent for alluvial gold.

Giles' Hole is a large waterhole in this gorge. At the third gorge, known as South Gap, the creek again passes through a deep ravine of quartzite, with flaggy and slaty beds below, dipping N. 60° to 70°. Below this, limestone country commences and forms rough ranges covered with spinifex. The limestone strata are vertical and contorted in dip, and contain chert and ironstone segregations; the general dip is N. At all these gorges, viz., Giles' Hole and the South Gap, quartzite ranges of considerable elevation are cut through by the creek.

As the drainage from the auriferous area at Arltunga comes down this creek, and also as the rocks occurring in it are in places likely to be gold-bearing, the creek, flats, and bars are, therefore, worth prospecting for gold.

From Arltunga I returned to Alice Springs.

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## ALICE SPRINGS NORTH-WESTWARD TO COUNTRY LYING SOUTH-WESTWARD OF BARROW CREEK (MAP No. 3).

Leaving Alice Springs on June 11th I proceeded, *viâ* Bond Springs, Burt well, and Connor's well, to Ryan's well on the telegraph line.

At Bond Springs station I found a collection of minerals, which proved to be zircons, with apatite and magnetite. I was informed by Mr. Taylor, the manager, that these had been obtained in the ranges some sixty miles off. As there was no water on the route he was unable to show me the place, but promised to make a further examination of the locality on the first opportunity. From Bond Springs I proceeded to Burt Well by the inside road, which follows the margin of the ranges. The rocks passed over consist of granite, syenite, diorite, and schistose granitic rock, with quartz reefs, and are favorable to the occurrence of gold. In the vicinity of Ryan's well the rocks are micaceous and siliceous metamorphic granite and gneiss, sometimes having a schistose and slaty structure, and striking E.N.E.; they contain large glassy quartz reefs. A hill and range three miles north-westward is composed of gneiss and granite, also striking E.N.E. Hann's Ridge, which is seven miles south of Ryan's well, trends E. and W.; it consists of sandstone, quartzite grit, and conglomerate dipping N. at 20° off metamorphic micaceous sandstone, mica schist, &c.

June 17th.—Proceeded along the telegraph line five miles over loam plains with quartz, gravel, and sand, bordered by gneiss and granite hills; thence followed an old road for ten miles through gneiss and granite ranges, the last five miles being down a sandy creek flowing north through a valley bounded on the right by high rounded ranges and on the left by rough ridges, also of gneiss and granite. Veins and reefs of white glassy quartz occur occasionally in these rocks. After travelling nine miles further in a general E.S.E. direction reached Anna reservoir, the rocks passed over being siliceous metamorphic granite, diorite, and syenite, with mica slate in a belt about half a mile wide, and solid boulder granite.

Anna reservoir is a deep rockhole some 20yds. in diameter, in the bed of a creek flowing southward out of rough ranges. The rocks are hornblendic and micaceous schists, quartzite, and siliceous hornblendic flags and slaty beds, gneiss, and granite, striking N., and dipping N.E. and vertically, with a little eruptive granite and quartz.

Some old stone huts here mark the site of the deserted station which some years ago was attacked by blacks, who badly wounded the two men in charge.

June

June 18th.—Proceeded eastward round the south side of the range, which is composed of gneiss and granite, with slaty beds dipping off them to the N.E. At five miles passed a hill rising about 1,500ft., and having a trig. on top (Mount Freeling?), and followed along a plain, with high steep ranges on the north, for twenty-one miles, to a gum creek (the Twenty-mile) coming out of a gorge, in which there is a large waterhole. Tracks of cattle and blacks were numerous. Camped one mile west of this creek. A large mob of blacks appeared before sundown. Three of these, who said they had been to Alice Springs, were allowed to come into the camp. Two of them were badly gashed with knives, and all three were suffering from a bad attack of influenza.

June 19th.—Followed on westward along the range, which is composed of the same kind of rocks, nine miles to a gum creek (the Thirty-mile), on the banks of which there are the ruins of an old station and yards. Two miles up the creek came to rock waterholes in the creek bed, and again at three and four miles to other waterholes. The rock formation is solid gneiss and granite, with a few quartz reefs. These waterholes appear to be permanent, that is, are large enough to last over the period between the annual heavy rains. Camped at fourteen miles. The range, which has been continuous from Anna reservoir, here breaks up into scattered broken hills of low elevation. Southward and south-easterly the hills are flat-topped.

June 20th.—Proceeded north-westerly over plains with low rises and hills of gneissic granitic rock, opening in that direction and north-westerly into a wide plain showing here and there distant peaks and points of ranges. At eight miles passed a hill of schistose, gneiss, and granite, with bunches of quartz. Northward of this plain a high range, rising from 1,000ft. to 1,500ft. or 2,000ft. above it, extends north-westerly, and gradually fades away in the distant horizon. As this range is unnamed I have marked it on the map Buxton Range, in honor of His Excellency the Governor.

At nine miles reached a small sandy creek, with large white gum trees. Marked one of these $\overset{B}{\uparrow}$ 20/6/96. As there was no likelihood of water further westward, the ground being flat and open, and the country having all the appearance of suffering from a long drought, I decided not to proceed further in that direction, being provided with horses only. Therefore started in a north-easterly direction towards a point of the high range running north-westward above-mentioned (which point I take to be Mount Thomas). Arrived at the base of this range at thirteen miles, having passed over loamy plains with grass, mulga, and saltbush; thence up a gum creek one and a half miles to a gorge, expecting to find water in a large rockhole at the foot of a cliff, but it contained no water. Returned one and a half miles, and camped without water. The rock formation is quartzite, yellow and grey in color, in massive vertical beds striking E. and W., and having an elevation of 1,500ft. or more above the plains.

June 21st.—Proceeded south-easterly across the plain, and returned to the camp on Thirty-mile Creek, over red loam and sand plains, with an occasional outcrop of gneissic schistose granite; struck the creek at twelve miles, and followed it down to the camp, passing two or three large waterholes on the way.

June 22nd.—Proceeded up the same creek, clearing the ranges at two miles; thence in an easterly and E.N.E. course over plains, undulating country, and rises covered with broken quartz overlying kaolinised granite, to a divide at eleven miles, the rocks being kaolinised granite, quartzite, and metamorphic schistose sandstone, and coarse granite; the high range lying a short distance northward of Anna reservoir ranges lying southward. From this divide continued easterly over similar rocks, in places covered with loam and quartz drift, and struck a creek at six miles trending east. Followed this creek down twelve miles through rough country into steep ranges, consisting of quartzite on granite, and gneissic rocks, and camped without water. Passed numerous rockholes, but found no water in them; apparently no rain had fallen for a long period.

June 23rd.—Followed the same creek, which is here of considerable size, down six miles on to grassy plains, where it turned northward. Left it at this point, and proceeded eastward four miles round the southern end of gneiss and granite ranges, and struck the Woodford Creek and an old track. Followed this track nine miles over river plains, and obtained water by digging 3ft. in the sand of the Woodford at a place known as Johnstone's well. Camped seven miles lower down the creek without water at a place known as the Woodford Crossing, and on the telegraph line. Wide alluvial plains border the Woodford, and extend eastward and westward beyond the Hanson for many miles, no hills being visible.

June 24th.—To the Teatree well on the telegraph line fourteen miles, still over the loamy, well-grassed plains of the Hanson and Woodford. Seven miles from this well passed a low range of metamorphic grit and sandstone, and camped without water three miles further on the Hanson, a few miles southward of Central Mount Stuart. Some low hills in this neighborhood are composed of argillaceous slate, jasper quartzite, sandstone, and metamorphic granite, with quartz reefs.

June 25th.—Five miles from camp reached Bullocky Camp, where there is a water soakage in the sand bed of the Hanson; found this was dry. Continued fifteen miles further down the Hanson to the Eight-mile (on Hanson) well, thence to Stirling station, eight miles.

June 26th.—From Stirling station to Barrow Creek telegraph station, eighteen miles.

In concluding this report it may be stated that the ranges in the neighborhood of Anna reservior, the Twenty-mile and Thirty-mile Creeks, where schistose and slaty rocks traverse the gneiss and granite, as well as portions of the flat country between these ranges and the next range north, should be prospected for gold. The occurrence of tin is also probable over any of the granite country. An exploration of the almost unknown country west of the telegraph line is a work which, if undertaken, would most probably lead to the discovery of additional areas worth prospecting. The waterholes on the Twenty-mile and Thirty-mile Creeks are permanent waters in an ordinary run of seasons, and they are suitable starting points for prospecting explorations. From these waters a party provided with camels would have no difficulty in examining the country as far west as the West Australian border.

## BARROW CREEK TO FREW RIVER AND ELKEDRA, COUNTRY LYING EAST, NORTH-EAST, AND NORTH-EASTWARD OF BARROW CREEK, IN THE VICINITY OF THE MURCHISON RANGE (MAP No. 4).

Leaving Barrow Creek telegraph station on July 1st I started with the same equipment of horses, and in addition a camel and black boy, borrowed from the Police Department, who have a station at this place. After going four miles the pack and loose horses became disorganised at the appearance of the camel, which had come up behind them, and bolted, two of the most frightened galloping eight miles along the telegraph line, and travelling altogether about fourteen miles before they were overtaken. At twenty-five miles reached Taylor well and camped.

July 2nd.—Started on the Frew river track from Taylor well, leaving the telegraph line at that point, and proceeded eastward fifteen miles to the First Mulgas, over red loam and sand plains, with low sandhills covered with spinifex and bushes; thence eleven miles over similar country, and camped without water on a grassy plain with mulga and white gum trees.

July 3rd.—Continued north-easterly and northerly, passing the Second Mulgas (the usual camping-place on this track) at one mile, and some low rises of travertine limestone rising out of the loamy plain at intervals for three miles. This is a suitable place for sinking a well should water be required hereafter. At eighteen miles reached Murray Downs, a deserted cattle station, where there is a large waterhole in a gum creek known as Spence's Creek, having passed over grassy loam plains with mulga trees. Three miles further up the creek eastward came to a waterhole in sand and conglomerate, near an old stockyard, and camped. This place is known as The Yards.

July 4th.—Continued following up Spence's Creek, which is joined by a large branch creek a little below this waterhole, over alluvial flats for eight miles to Johnson's waterhole. Four miles after leaving The Yards flat-topped ranges, composed of quartzite and sandstone, having an elevation of about 150ft. above the general level, were passed on either hand, lying some three or four miles apart. Above Johnston's waterhole the creek splits into branches, which have their source in these ranges, flowing through narrow plains between the sandstone and quartzite escarpments. At eighteen miles ran one of these branch creeks up to a saddle, known as the "Divide," and crossed on to the watershed of another creek, one of the heads of Frew river. Followed this creek down for seven miles over a grassy plain lying between quartzite and sandstone hills and ranges, and through a gorge to a deep waterhole, and camped. The hills here rise about 150ft. above the plain, and are composed of quartzite beds, striking N. and S., and dipping 50° to 60° E. This place is known as the "Old Camp."

July 5th.—After going two miles further down the creek over a valley bounded by quartzite, passed through another quartzite gorge, below which is a large waterhole in the creek bed, succeeded again by a valley or plain between the hills extending for six miles where the creek again enters a quartzite gorge, in which it continues for about one and a half to two miles, part of the way through which there is a large waterhole in conglomerate rock. This water is about eight miles below the last. From this place, after following the creek or river about one mile, left it to the west, and proceeded over grassy plains, with detached hills of quartzite and sandstone, for five or six miles, at which distance the creek again comes in from the westward, and then trends northerly. After crossing a large creek, known as Hatche's Creek, coming into the Frew from the eastward, followed down the Frew six miles to the Frew River station, which is situated in a bend of the river, near a large and deep waterhole. From the junction of Hatche's Creek the river flows through gorges and hills of sandstone, quartzite, and conglomerate (quartz pebbles in sandstone and quartzite) in undulating, horizontal, and inclined beds. A few quartz reefs containing solid oxide of iron occur in these rocks.

The cattle station was abandoned a few months ago, and the buildings are already falling into disrepair. In a garden attached melons and Cape gooseberries were growing, and one or two banana trees. Besides the main waterhole near the station, which is apparently deep, and extends for a distance of a quarter to half a mile, there were long stretches of water higher up the creek for two or three miles, forming a chain of waterholes. The distance to Tennant's Creek is about seventy miles in a straight line, the direction being W.N.W. The Frew, so far as can be judged by a view from the adjoining hills, trends northward for two or three miles, where it clears the quartzite and sandstone ranges. From this point it appears to trend in a north and north-easterly direction through plains and low country. Hills and ranges, apparently of the same formation, are visible in the distance.

July 7th.—Left Frew river and proceeded towards Elkedra on the outgoing track as far as Hatche's Creek (six miles), where a pad turns off to the south-eastward. Went south-eastward, S.S.E. and southward. At four miles a change of the rock formation takes place, diorite rocks and blue metamorphic quartzite outcropping, and continuing for a mile or two, after which they are again overlaid by quartzite and sandstone. At eleven and a half miles reached a small waterhole in Hatche's Creek, which runs through grassy flats, bordered by low flat hills of quartzite. In one place this quartzite is inclined at an angle of 45° to the S.E. Continued following up Hatche's Creek in a general southerly direction nine miles to a dividing range, passing three waterholes at one mile, and two waterholes at two miles. After going four miles the quartzite and sandstone rocks gave place to underlying schistose, granite, and argillaceous rocks, with quartz reefs striking N. and S.; some of these contain tourmaline. They form low-rounded, grassy hills, covered with quartz gravel and fragments. This area is a likely one for gold, but is not of large extent. It is again overlaid by quartzite at the divide. Crossing on to the other watershed descended about 200ft. on to a creek flat and plain, reaching a quartzite gorge three miles further southward, on which are two waterholes; passed through this, and camped on a grassy plain bounded by quartzite and sandstone hills rising from 100ft. to 150ft.

July 8th.—Proceeded southward over grassy plains bordered by quartzite and sandstone hills, crossing a large gum creek at five miles and low limestone hills at eight miles. At nine miles came to Elkedra, a deserted cattle station. There is a long and deep waterhole in the Elkedra Creek at this place extending eastward through a deep ravine in quartzite rock containing a quartz reef; the quartzite dips S.W. at 40°. The waterhole is said to be 40ft. deep and to have lasted for three years' of drought when the country was stocked without failing. From Elkedra went S.W. five miles over grassy plains to a large waterhole below a gap in a quartzite and sandstone range where the creek comes through. Passed through this gap, and followed up the creek for twelve or fourteen miles westerly and N.N.W. over well-grassed plains bounded by low flat-topped quartzite and sandstone hills, having an elevation of about 100ft. above the general level.

July 9th.—Went N.W. and W.N.W. over similar grassy country with low quartzite ranges; crossed a low divide at seven miles, and struck Johnson's waterhole on Spence's Creek, which I had passed in going to Frew river on the 4th July at nineteen miles. Returned along outgoing track seven miles to The Yards, and camped at the waterhole.

July 10th.—Started about noon, and returned along outgoing track to my old camp near the Second Mulgas, a distance of about nineteen miles, and camped without water.

July 11th.—Travelled from camp along track, *viâ* the First Mulgas, to Taylor well, a distance of twenty-six miles.

July 12th.—Taylor well to Barrow Creek telegraph station.

The prevailing rock formation in that portion of the Murchison Range in which Elkedra and Frew river are situated is quartzite, sandstone, and conglomerate, in horizontal, undulating, and uptilted strata. These rocks form flat-topped and rounded ranges rising from 50ft. to 200ft. above the general level of the country. In some places they contain quartz reefs of large size, but these have not a particularly likely appearance for gold. Between Elkedra and Frew river, up Hatche's Creek as far as the watershed, between that creek and Elkedra Creek, there are, as I have said, patches of schistose rocks with diorite and quartz reefs, which are likely to be auriferous. It is probable that there are larger areas of these rocks outcropping to the eastward of Frew river and Elkedra. The large permanent waterholes at both Elkedra and Frew river station are most convenient places for depôts in connection with any prospecting operations that might be undertaken.

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The geological formations found to exist in the several areas referred to in these reports are few in number. The gneiss and granite, with accompanying interstratified beds of schistose metamorphic rocks, quartzite, sandstone, limestone, &c., and intruded granitic dioritic and felspathic dykes are the Archæan or foundation rocks of the whole region.

Overlying these are the crystaline dolomitic limestones, with clayslates and quartzite, which are in turn overlaid by quartzite, sandstone, grit, and conglomerate beds, which, although conformable in places where the strata are horizontal or only gently inclined, in other places are apparently uncomformable. No fossils have yet been found in either the limestone or the quartzite and sandstone series. There is, therefore, no evidence to indicate to what group of the Palæozoic period they belong.

Overlying all these formations extensively are the alluvial deposits of the creeks, the sand, clay, loam, and gravel of the plains, which hide from view any rocks of Tertiary or Secondary age which may intervene.

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In connection with these reports I submit a section of the country from near Barrow Creek to Oodnadatta, with the following notes on the various rock formations occurring:—

### Archæan Gneiss, Granite, &c.

These are the oldest rocks of this region, and form the foundation on which all the succeeding rock formations are built up. The strata composing them where not too much altered by upheaval and the presence of igneous dykes, are distinctly stratified, quartzite, crystalline limestone, siliceous, argillaceous, micaceous, hornblendic schists, and sandstones, being interstratified with gneiss and granite. This stratification is very clearly marked in the Hart Ranges and many places in the Macdonnell Ranges, especially where the limestone beds occur. The general strike of these rocks varies from E. and W. to N.W., and the dip from N. to N.E. The gneissic structure usually conforms to the bedding of the less altered rocks.

### Cambrian.

The limestones and dolomite limestones, with chert, quartzites, sandstones, slates, and grit conglomerate of the Ooraminna Range (between Ooraminna Rockhole and Ooraminna Gates) and James' Range (between Deep Well and Francis Well) are lithologically similar to those constituting the Dennison and part of the Peake Range, the Mount Nor'-West, and the portions of the main range southwards and the ranges to the E. and S.E. of the Musgrave Ranges. The outcrops near Horseshoe Bend on the Finke and at Mount Dutton appear also to be the same; the dolomitic limestone, however, is not visible, the area exposed in each case being very limited. The quartzite and dolomitic limestone at Heavitree Gap, which are more extensively developed eastward along the Macdonnell Ranges, I take to be part of same series.

No fossils have yet been found in these rocks in this part of the country, but in the main or Flinders Range, in rocks lithologically similar, fossils of Cambrian age have been determined by Mr. R. Etheridge, jun. (*vide* Transactions of the Royal Society of South Australia, 1890.) These rocks seem to me to belong to one continuous system, extending from the Flinders Range to the Macdonnell Ranges, and therefore, until clear fossil evidence to the contrary is obtained, they may be classed together as Cambrian.

The strike of these rocks at Heavitree Gap is E. and W., and the dip S. at high angles. At Ooraminna Range the strike is N. and N.N.E., and the dip westerly at angles from 10° to 45°. At James Range the strike is E. and W., N.N.W., &c.; here they are folded into anticlinal arches and synclinal troughs. Near Horseshoe Bend on the Finke they strike N.E. and dip N.W., and are overlaid by beds of pebble conglomerate dipping N. at 20°. At Mount Dutton they strike N. and S., and dip 45° to the W.

### Lower Silurian.

At Horseshoe Bend and elsewhere on the Finke river and eastward towards Idracowra there are undulating beds of reddish and pale-colored micaceous sandstone and shale, which are probably a continuation eastwards of the Lower Silurian rocks of the Tempe Downs district rocks. I am not aware of any fossils having been found in them, but judge by their lithological resemblance and the fact that they extend north-westwards up the Finke.

### Jurassic.

### Jurassic. (?)

The sandstone, calcareous sandstone, thin bedded limestone, and quartzite of the Ooraminna Range and James Range, containing pebbles of quartz, quartzite, and other siliceous rocks, and the false-bedded argillaceous and micaceous sandstones, with pebble and boulders, of the Hugh and Finke rivers, from near Francis Well to the Goyder river, resemble lithologically the sandstone grit and conglomerate found to underlie the cretaceous shales on the borders of the Peake and Dennison Ranges and in the bottom of the bores at Hamilton Creek and Oodnadatta. The Ooraminna and James Range rocks were provisionally classed by me as Devonian on lithological grounds, no fossils having been found. They strike E. and W., and dip S. From what I have observed since, I think they are most probably a continuation of the Hugh and Finke rivers, false-bedded sandstones which dip under the cretaceous shale formation in the vicinity of the Goyder river.

In the bores to the westward of Coward's Springs (at Cooric Appa), on the edge of the cretaceous shale formation, sandstone containing pebbles of quartz, quartzite, &c., is found to underlie the shale, and is underlaid itself by purple slate or shale. These sub-cretaceous beds either belong to the cretaceous system which they underlie, or are of still greater mesozoic age.

There is no doubt but that these are the porous beds which absorb the water coming from the Macdonnell and other ranges down the Hugh, Finke, and other rivers, and conduct it beneath the impervious cretaceous shale formation, where it is stored at a pressure sufficient to cause an artesian flow to rise above the surface when the latter formation is bored through. In the Hamilton bore this sandstone and gravel formation was met with at 1,140ft. from the surface, water being struck at the same depth. The bore was continued to 1,417ft. through sandstone and grit beds containing quartzite, quartz, sandstone, and other pebbles, and a supply of 792,000galls. per diem obtained at that depth. In the Oodnadatta bore, about sixty-two miles south of the Hamilton bore, similar sandstone beds with pebbles were met with at 1,417ft., and artesian water struck at that depth. The bore was continued through these beds to 1,571ft., and a supply of 270,000galls. per diem of water obtained.

### Lower Cretaceous.

The formation consists chiefly of a bluish argillaceous shale, with occasional limestone, sandstone, and ironstone and pyrites bands. The thickness of the main shale formation, proved by the Oodnadatta bore, was 1,417ft.; by the Hamilton bore, 1,140ft. The northern boundary of this formation is probably somewhere between Charlotte Waters and the Goyder river. Owing to its being overlaid by newer formations, this cannot be ascertained with certainty unless by boring, as also the presence or absence of any outlying area of the same formation northward of that line of boundary.

### Upper Cretaceous, or Tertiary.

These beds overlie the cretaceous shale formation from Oodnadatta to beyond Charlotte Waters and all the other rock formations northward, capping the tablelands and tablehills.

Between Oodnadatta and Charlotte Waters they are best developed, and attain a thickness of 200ft. to 300ft. in places, and consist of jasper rock, quartzite, porcelainite, breccia, and conglomerate, resting on argillaceous sandstone and white shale, which resembles kaolin, but is often a siliceous rock. North of Charlotte Waters the flat-topped hills are capped with this jasper rock, quartzite, and conglomerate, resting on white horizontal argillaceous sandstone.

These cappings thin out northwards, but are found even on the flanks of the Macdonnell Ranges. It is doubtful whether the cappings are all of the same age. In many cases they are merely probably the upper portions of the older strata, which have been porcelainised by the infusion of siliceous waters.

### Recent and Tertiary.

These are the alluvial, sand, clay, loam, gravel, travertine limestone, conglomerate, &c., of the creek and river flats and plains. Between the Foster Range and Mount Boothby Range a large area is occupied by them. Owing to their forming a wide-spread covering at that place, and on the Burt plain, Todd river valley, and other places, as shown on the section, the underlying rocks are hidden, and rock formations may exist beneath them which do not come to the surface, and are therefore unknown.

# OFFICIAL CONTRIBUTIONS TO THE PALÆONTOLOGY OF SOUTH AUSTRALIA.

*By R. Etheridge, Junr., Curator of the Australian Museum, Sydney.*

## No. 9.—ON THE OCCURRENCE OF *OLENELLUS* IN THE NORTHERN TERRITORY.

In his "Report on Northern Territory Explorations" (1) the Government Geologist (Mr. H. Y. L. Brown) refers to the discovery by him of a Trilobite head on Alexandria Cattle Station, Playford Creek, in Lat. 19° 10″, Long. 136° 45′ (approximately). The specimen was found in the spoil heap of a well, 200ft. deep, five miles north of the station, and about 110 miles north-west of Camooweal, on the Queensland border. A reference to Mr. R. L. Jack's latest edition of the Geological Map of Queensland (2) will show that the rocks around Camooweal, at the heads of the Georgina River, consist of the Rolling Downs Formation (Lower Cretaceous). The nearest Palæozoic rocks shown on this map, slates and schists of undetermined age, marked Q, is an extension northwards of the large belt comprising within it the Cloncurry Goldfields, in the district of Beaconsfield. Nothing was known of the age of this Cloncurry belt beyond that it was believed to be Lower Palæozoic until very recently. The position of the Alexandria deposit is shown on Map No. 8, accompanying Mr. Brown's Report.

The Trilobite head from Alexandrina I believe to be referable to the remarkable Cambrian genus *Olenellus*, and it is now proposed to describe it as:—

### Olenellus Brownii, *sp. nov.*—Pl. 1, Fig. 1.

*Sp. Char.*—General form unknown. Cephalon, or cephalic shield, subsemicircular; width all but double the length; frontal and lateral borders thickened and raised; posterior border to all intents and purposes straight. Glabella rather pyriform, in front abutting against the frontal border; axial grooves well marked and deep; basal furrow continuous across the glabella, and very faintly V-shaped; the second and third furrows horizontal, leaving between their inner ends a slight median longitudinal convexity; frontal lobe subsemicircular and largest, the second lobe next largest, the third next, and the basal lobe smallest, the two halves of the latter being somswhat wedge-shaped. Neck segment narrowly oblong, with a central tubercle; neck furrow deep and horizontal. Eye lobes narrow, semilunate, extending from opposite the foremost pair of glabella furrows to the posterior margin; palpebral lobes appear to be deltoid; genal spines short extending to the third and perhaps the fourth pleura. Two anterior thoracic segments of equal width, slightly convex, of equal width with the pleuræ, or if anything very slightly wider, devoid of median spines or nodes; two anterior pleuræ flat, slightly inclined from the axis, the geniculation apparently feeble, the anterior margins strong and very marked. Sculpture anastomosing lines faintly visible on the cheeks.

*Obs.*—This very interesting specimen consists of the cephalon, portions of two axial thoracic and three pleural segments, but there is no trace of the pygidium. One of the chief peculiarities of this Trilobite is the width of the palpebral lobes separating the central and hinder parts of the eye lobes from the glabella, and the contiguity of the eye lobes to the lateral portions of the cephalic border, rendering the intervening portion of the cheeks very narrow.

*Olenellus Brownii* bears no relation to any other Australian Trilobite, and departs from the structure of a large number of American species, such as *O. Thompsoni*, Hall (3), and *O. Gilberti*, Meek (4), in the before-mentioned contiguity of the ocular lobes to the lateral borders. Herein it agrees with some Swedish forms, such, for instance, as *O. Kjerulfi*, Linnarsson (5), and also resembles the genus *Protolenus*, Matthew (6), but not in any other character.

In the pyriform glabella *O. Brownii* departs from Hall's original definition of *Olenellus*, where the glabella is said to be "of nearly equal width throughout, or slightly narrowing, and rounded in front." It is, however, in accord with his description in that the posterior pair of glabella furrows is "nearly or quite continuous across from the posterior angles of the eyes." Professor James Hall says that the large and well developed eyes extend "from near the base of the shield more than half-way to the anterior margin." In *O. Brownii* these organs extend considerably more than half-way towards the anterior border of the shield. In Professor C. Lapworth's restoration (7) of his *O. Callavii* the glabella is practically straight-sided, the axial portion of the thoracic segments are spine-bearing, the genal spines extend backwards to the fifth segment, and the eye lobes are not contiguous to the lateral borders of the cephalic shield.

Hall originally described each branch of the facial suture as extending "in a curving line from the front margin to the anterior angle of the eye, and from the posterior angle of the eye it turns abruptly outwards towards the posterior lateral angle of the cephalic shield." Mr. C. D. Walcott appears to have adopted this definition in his earlier writings, for we find him remarking (8) "We invariably find the line of the suture running obliquely outward and terminating at or very near the pleural angle. It occurs in this way in all other species of the genus in which we have observed the suture." In his more extended contribution to the "Fauna of the Olenellus Zone" (9), however, he remarks on the absence of a true facial suture in *Olenellus*, saying "in none of the species is there a facial suture such as characterises the family Paradoxidiæ," and on this account he places the former genus in a separate family to *Paradoxides*. Now, our specimen leaves me somewhat in doubt as to its true structure in this respect. On the left hand side of the head shield of the latter there is a line of separation exactly corresponding to the fore part of the supposed facial suture figured by Mr. Walcott in *O. Gilberti* (10), but on the right this is only represented by a slight nick or break in the frontal border. Mr. Walcott subsequently remarked that what he had identified as the facial suture in another species (*O. asaphoides*, Emmons, sp.), "is a raised line in the cast of the interior of the shell that fills a depressed line occupying the position of the suture." He adds—"I have since found this depressed line in many specimens, but in none is there a true suture cutting through the shell as in Paradoxides, and most other genera of Trilobites" (11).

In the Australian example there is no evidence of any posterior division of the facial suture, *i.e.*, behind the eyes, and I am therefore led to believe that it is probably in accord with Mr. Walcott's later observations.

More

(1) S. Australian Parl. Paper, 1895, No. 82, pp. 24 and 34. (2) Geol. and Pal., Queensland, &c., 1892. (3) Walcott, Bull. U.S. Geol. Survey, 1886, No. 30, t. 17, 22, 23. (4) *Ibid.*, t. 21. (5) Holm, Sveriges Geol. Undersokning, Afhandl., 1888, Sec. c., No. 93, t. 14, f. 2., t. 15, f. 10. (6) Bull. Nat. Hist. Soc., N. Brunswick, 1892, No. x., p. 34. (7) Geol. Mag., 1891, viii. (3), t. 15. (8) Bull. U.S. Geol Survey, 1886, No. 30, p. 161. (9) 10th Ann. Report *ibid.*, 1890, p. 635 (10) Bull. U.S. Geol. Survey, 1886, No. 30, t. 18, f. 2. (11) 10th Ann. Report, *ibid.*, p. 653.

More particularly is this the case, because on the fore part of the glabella are certain breaks that are unquestionably cracks of the surface of the fossil, and as these are in connection with the before-mentioned line on the left-hand side, through the third glabella furrow of the same side, I think they may, one and all, be ascribed to fracture, and are not structural.

With regard to the thorax, only three segments are partially preserved, and not even sufficient of the third to say whether or no its pleuræ are prolonged into extended backwardly projecting spines. The absence of these prolongations, if proved, would bring *O. Brownii* still more in accord with the Swedish *O. Kjerulfi*, in which they are also wanting.

Nothing is known of the pygidium, although on the same piece of schist a very small and imperfectly preserved tail is present, but I do not think it appertains to this Trilobite. It is triangular, with an entire border, and that is all that can be said about it.

In *Olenellus*, broadly speaking, three sections are recognised by Mr. Walcott, viz.:—

Olenellus, *Hall*—ex. O. Thomsoni, *Hall.*
Mesonacis, *Walcott*—ex. O. Vermontana, *Hall.*
Holmia, *Matthew*—ex. O. Kjerulfi, *Linns.*

In *Olenellus* proper the third thoracic segment has its pleuræ prolonged into large reflected spines, of variable length, according to species, and the pygidium provided with a long terminal spine or telson.

In *Mesonacis*, whilst the pleuræ of the third thoracic segment are somewhat similar, the fifteenth segment is provided with a long central acicular spine that lies back on the middle line of the pygidium, and the latter is much elongated, but there is no telson.

In *Holmia* each thoracic segement bears a large, stout, median spine. In *Holmia Bröggeri*, Walcott, the spine of the first segment of the thorax is long and acicular, extending backwards for some distance whilst the pygidium is very small, transverse, and almost quadrangular in form.

As a matter of personal opinion, I am inclined to regard these sections as separate genera. The imperfect condition of Mr. Brown's specimen renders it impossible to say to which of the three it appertains, but, judging from the resemblance of the cephalic shield to that of *H. Kjerulfi*, it is possible it may be referable to *Holmia*.

The legitimate conclusion to be drawn from the occurrence of this fossil at Alexandria Station, without strong negative evidence to the contrary, is the presence of a still further Cambrian area in Australia.

It will be very interesting in the future to ascertain the relation of the Alexandria deposit to those along the Northern Territory and Queensland border already referred to as mapped by Mr. Jack.

In his "Annual Presidential Address" to the Royal Society of South Australia on October 1st, 1895 (12), Professor Ralph Tate referred to the discovery of the "impression of the upper surface of an Euomphaloid shell," at twenty miles west of Took's Waterhole in the Cairns Range, a locality in Mr. Jack's "slates and schists of an undetermined age." Professor Tate considers that this fact indicates the extension of the Ordovician rocks of Central Australia to the borders of Queensland, and the probability of their occurrence within the boundary of the latter colony. This opinion seems to be founded on the resemblance of the Euomphaloid cast to "several specimens of an *Euomphalus* or *Oriostoma*-like shell" from the Lower Silurian rocks of the Macdonnell Range, collected by the Horn Expedition. The Palæozoic age of this patch of rocks is, I think, unquestionable, for, without laying too great a stress on the Euomphaloid shell, much more satisfactory evidence has recently come to hand in the form of two well-marked Orthoceratites. These are from thirty miles east of the Northern Territory and Queensland border, and on the eastern edge of Took's or Cairns Range in Lat. 23° S. The specimens were forwarded to me by Mr. Jack for identification.

## No. 10.—THE PERMO-CARBONIFEROUS FOSSILS OF TREACHERY BAY, VICTORIA RIVER.

A preliminary list of the organic remains from Fossil Head, Treachery Bay, at the north-east entrance of the estuary of the Victoria River, known as the Queen's Channel, has already been given (13), accompanied by some geological and historical notes on the locality.

The following descriptions are those of the more perfect specimens in the collection, but none are in a condition fitting them for more than casual study from a palæontological point of view. From a geological standpoint, however, the importance of this collection is great, proving within certain limits the age of the formation yielding them.

The fossils are in a ferruginous sandstone that has become hardened by exposure to the air, not a medium well suited to the preservation of structure. The surface of each fossil is much darker than the matrix, and, in some instances, has assumed a partially glazed appearance. In none is the testaceous matter preserved, but is represented by a ferruginous replacement.

The mode of preservation, appearance, and identity of the fossils is so essentially that of those from Ironstone Ridge, twenty-five miles south-east of Yeeda Station, Fitzroy River, N.W.A. (14), that every probability exists of the two deposits being parts of one series, if not absolutely identical. Notwithstanding, therefore, the poor state of preservation of the present fossils, identity is much facilitated by the comparatively perfect state of those from Ironstone Ridge.

### Class Brachiopoda.

### *Genus* Rhipidomella, *Œhlert.*

(Journ. Conchyl., 1890.)

Rhipidomella australis, *McCoy*—Pl. 1, Fig. 2.

*Orthis australis*, McCoy, Ann. Mag. Nat. Hist., 1847, xx., p. 234, t. 13, f. 4-4a.

*Obs.*—The longitudinally obovate outline of this specimen is so characteristic of the species, narrowing towards the cardinal margin and broadening towards the front, that a description is hardly necessary. The side and front margins are but very little curved, almost straight in fact. The valve is slightly convex, with fine radiating costæ and broad laminæ of growth. It is apparently a ventral valve with the umbo and area lost.

*Rhipidomella australis* is a common species in the Carboniferous (not Permo-Carboniferous) beds of New South Wales, particularly at Somerton, where it may be met with of all sizes.

It takes the place of the European *R. Michelini* in Australian Carboniferous rocks. *Genus*

(12) Trans. R. Soc. S. Austr., 1895, xix., Pt. 2, p. 274. (13) S. Australian Parl. Papers, 1855, No. 82, p. 33.
(14) Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), Pt. 2, p. 202.

*Genus* Orthotetes, *Fischer (?).*

(Bull. Soc. Imp. Nat. Moscou, 1829, p. 375.)

*Obs.*—A small ventral valve (Pl. 1, Fig. 3) probably represents this genus. The costæ are very numerous and remarkably fine, alternately larger and smaller. Two or three broad laminæ of growth are present, but no trace of concentric lines. The dorsal margin was apparently long and the cardinal alations rounded.

Class Pelecypoda.

*Genus* Aviculopecten, *McCoy.*

(Ann. Mag. Nat. Hist., 1851, vi., p. 171.)

Aviculopecten Hardmani, *sp. nov.*—Pl. 1, Figs. 4-8.

*Sp. Char.*—Shell more or less suborbicular, both valves *apparently* alike, convex, rather markedly so from the umbo forwards, producing with the high lateral slopes an attenuated or narrowed appearance to that part of the shell. Hinge line as wide as the valves; ears large and flat (in one valve at least), and square. Sixteen to twenty prominent, rounded, primary costæ, with from one to three secondary between each pair of the former, crossed by numerous imbricating frill-like laminæ, echinate, more particularly on the posterior costæ, both primary and secondary, the laminæ edges where crossing the intercostal spaces convex towards the umbo; intercostal spaces flat.

*Obs.*—*A. Hardmani* is the commonest species in the collection, but in only three examples have I seen any trace of the ears preserved. In one of the specimens one ear is almost entire and square, but only the base of the other is preserved. I think, however, it was square also; both bear radiating costæ, similar to those on the body of the valves. When the echinated laminæ are worn down only a roughening of the costæ remains, whilst in the larger and older examples the latter broaden out and become much flatter.

This species differs essentially from *A. tenuicollis*, Dana, met with so plentifully at Ironstone Ridge, near Yeeda Station, on the Fitzroy River, principally in the outline of the valves, convex umbonal region, sculpture (so far as it is known in Dana's species), and in the possession of square ears.

It is a remarkable fact that the present form is as plentiful at Fossil Head as the variety of *A. tenuicoilis* found at Ironstone Ridge is there. On re-examining the specimens from the latter locality I noticed one small valve of the present species that had formerly escaped my observation.

*A. Hardmani* is one of the less commoner forms of *Avieulopeeten*, assuming through the high attenuated umbonal region and overarched umbo a rather *Vola*-like appearance. This resemblance is also noticeable in the prominent and comparatively large primary costæ.

This peculiar shell is fittingly named in honor of my late friend, Mr. E. T. Hardman, who accompanied the Kimberley and N.W. Australian Exploring Expedition as geologist.

*Genus* Edmondia, *DeKonivek.*

(Descrip. Anim. Foss. Terr. Carb. Belgique, 1842, p. 66.)

Pl. 1, Fig. 10.

*Obs.*—Like nearly all the shells from Fossil Head, this is imperfect. It is a deep and apparently suboval right valve, with a very moderately convex outline. There is an obtuse diagonal ridge, and concentric laminæ of growth, which at about one-half the depth of the valve become much more prominent and marked. I have referred this provisionally to *Edmondia*, but to some extent it reminds one of certain *Notomyæ*.

*Genus* Parallelodon, *Meek & Worthen.*

(Proc. Chicago Acad., 1866, i., p. 17.)

Pl. 1, Fig. 9.

*Obs.*—There is a very imperfect valve, perhaps referable to this genus, and possibly allied to *P. Fraiponti*. DeKon. (15). It is a rather deltoid left valve, with a strong diagonal ridge; that with the posterior slope almost forms a right angle. No trace of sculpture is apparent.

Class Gasteropoda.

*Genus* Mourlonia, *DeKoninck.*

(Ann. Mus. R. Hist. Nat. Belgique, 1883, viii., p. 75.)

Mourlonia humilis, *DeKon.* (?)—Pl. 1, Fig. 11.

*Pleurotomaria humilis*, DeKon., Foss, Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 325, t. 23, f. 14.
*Mourlonia humilis*, Eth. fil., Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), Pt. 2, p. 205.

*Obs.*—A depressed turreted shell, of which two and a half whorls are preserved, the larger probably being the body whorl. The latter is gently rounded above, with a well-marked narrow band above the greatest periphery of the whorl. No further details are preserved.

In 1889 I described a more perfect shell than the present, but apparently identical, from Ironstone Ridge, Kimberley, and referred it from the few characters it retained to DeKoninck's genus *Mourlonia*. The position of the band and appearance of the body whorl is in accordance with the fragment described by the same author as *Pleurotomaria humilis*. The shell is certainly one of the Pleurotomariidæ, but without ascertaining the condition of the umbilicus it is impossible to say definitely whether a *Mourlonia*, *Ptyehomphalina*, or *Gossletina*.

It is a much less turreted shell than a supposed *Mourlonia* figured by myself (16) from the Burnett District, Queensland.

*Genus*

(15) Faune Calc. Carb. Belgique, Pt. 5, t. 24, f. 3. (16) Geol. and Pal. Queensland, &c., 1890 t. 14, f. 9.

*Genus* Euphemus, *McCoy*.

(Synop. Carb. Lime. Foss. Ireland, 1844, p. 25.)

Euphemus Orbignii, *Portlock*—Pl. 1, Figs. 12 and 13.

*Euphemus Orbignii* (Portlock), Eth. fil., Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), Pt. 2, p. 206.

*Obs.*—A small specimen possesses the globular form of *E. Orbignii* and *E. Urei*, Flem. It consists of he larger part of the body whorl, with portions of the umbilicus. The terminal or younger part of the former is quite smooth, whilst the remainder bears close fine, equal, spiral, raised lines. There is the slightest trace of a band on the smooth portion, indicated by a faintly impressed groove, leading to an irregular fracture along the outer lip indicating the position of the slight sinus.

Amongst the West Kimberley fossils described by myself was this shell also. After the authority for the species I appended the expression "var." in consequence of the finer and more numerous spiral lines on the Kimberley shells than on the species proper. These exist on the present examples, although in a more accentuated form; nevertheless, the general habit is so essentially that of *Euphemus Orbignii*, I cannot do more than refer our shells to the latter.

*Genus* Bellerophon, *DeMontfort*.

(Conch. Systématique, 1808, i., p. 51.)

Pl. 1, Figs. 16 and 17.

*Obs.*—A portion of a shell similar to that described in the last species, possesses alternately larger and smaller spiral lines, covering the whole of the back of the body whorl. The umbilicus is open and fairly deep, with the alar expansions of the inner lip to some extent covering but not concealing it. There are indistinct traces of a band. The shell appertains to the section *Bucania*, DeKoninck, but not of James Hall. Specifically, it is undeterminable.

Bellerophon, *sp.*—Pl. 1, Figs. 14 and 15.

*Obs.*—A second and subglobular form, with a well-marked sinus in the outer lip, and the exterior carrying strong concentric imbricating folds or laminæ. The aperture is semi-lunate, apparently possessing a thickened outer lip, and the inner strongly reflected back over the umbilicus.

Although specific determination is not passible, it may be pointed out that this species belongs to that group of *Bellerophon* represented by *B. sublævis*, Hall *(non* Potiez and Michaux); *B. Münsteri*, D'Orb.; *B. plicatus*, DeRyck.; *B. hiulcus*, Martin, or *B. Jonesianus*, Waagen. With the exception that it does not possess the alations of *B. stanwellensis*, mihi., the shell might pass for a small form of the latter.

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## DESCRIPTION OF PLATE.

Olenellus Brownii, *Eth. fil.*

Fig. 1. Cephalic shield, showing the glabella and its furrows, eye-lobes, right genal spine, and portions of thoracic appendages. × 2.

Rhipidomella Australis, *McCoy*.

Fig. 2. Portion of a valve, probably the dorsal.

Orthotetes (?) *sp.*

Fig. 3. The greater part of a valve, probably the ventral, showing costæ and laminæ of growth.

Aviculopecten Hardmani, *Eth. fil.*

Fig. 4. Valve with square ears, high umbonal region, and high echinate costæ; there is a secondary costa between every two primary.

Fig. 5. Another valve in which the ears are more expanded, the umbonal region less high, and three secondary costæ between every two primary. × 2.

Fig. 6. Side view of Fig. 5. × 2.

Fig. 7. Portion of an older specimen, in which the costæ have become much flatter.

Fig. 8. Portion of an older specimen with three secondary costæ between every pair of primary.

Parallelodon (?) *sp.*

Fig. 9. An imperfect and much worn left valve, possibly referable to this genus.

Edmondia (?) *sp.*

Fig. 10. An imperfect right valve referable to this genus, or perhaps even to *Notomya*.

Mourlonia humilis, *DeKon*.

Fig. 11. A specimen exhibiting two and a half whorls, and traces of the band.

Euphemus Orbignii, *Portlock*.

Fig. 12. The body whorl, with equal spiral lines half encircling the whorl, and traces of the sinus.

Fig. 13. Side view of Fig. 12, with traces of the umbilicus.

Bellerophon, *sp.*

Fig. 14. Subglobular form, with a well-marked sinus in the outer lip, lunate mouth, and strongly reflected inner lip.

Fig. 15. Front view of the body whorl, with the sinus and transverse laminæ.

Bellerophon, *sp.*

Fig. 16. A shell similar in appearance to Fig. 12, but with alternately larger and smaller spiral lines covering the whole of the body whorl.

Fig 17. Side view of the same, with a deep open umbilicus.

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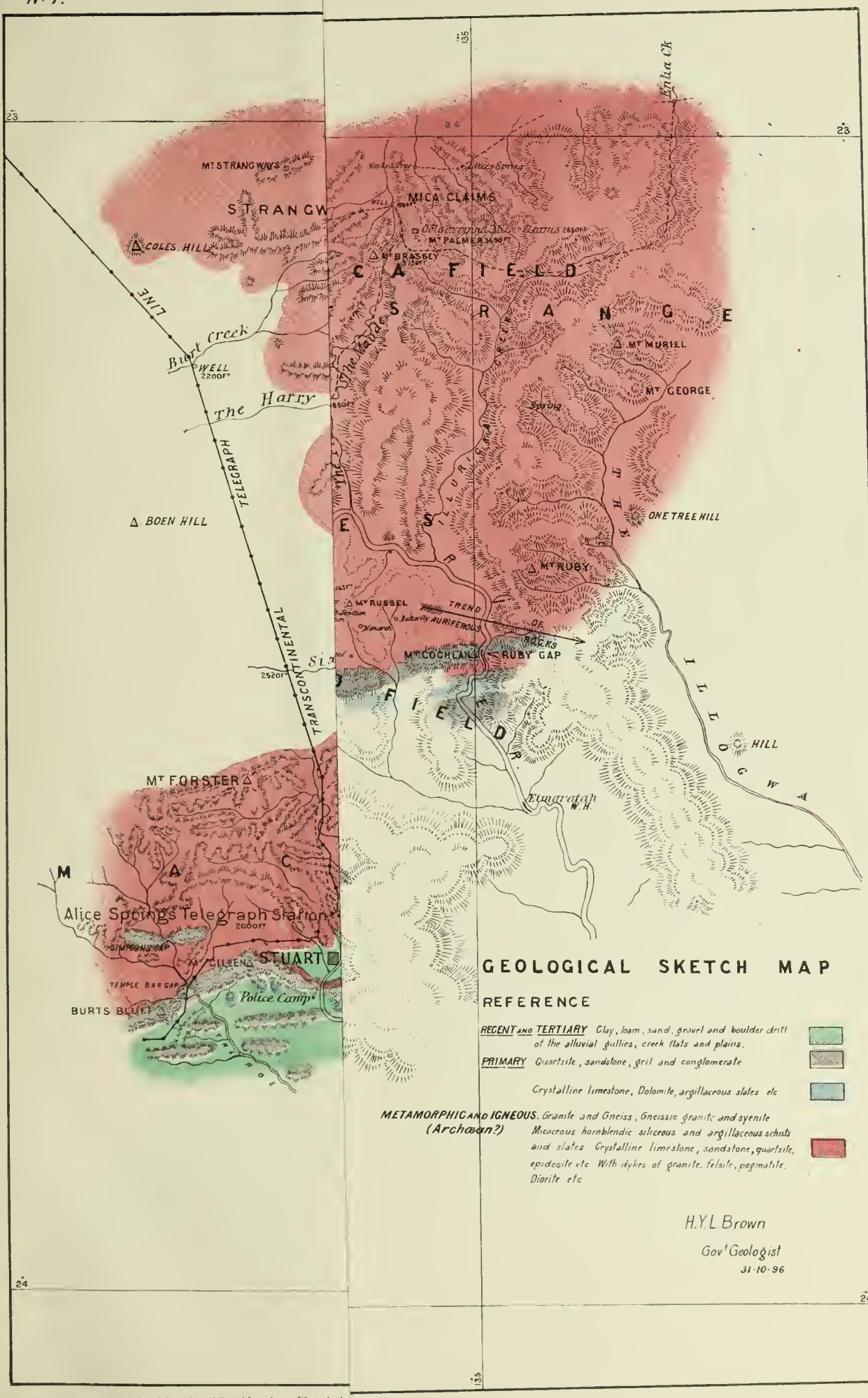


## GEOLOGICAL SKETCH MAP

### REFERENCE

**RECENT AND TERTIARY** Clay, loam, sand, gravel and boulder drift of the alluvial gullies, creek flats and plains.

**PRIMARY** Quartzite, sandstone, grit and conglomerate

Crystalline limestone, Dolomite, argillaceous slates etc

**METAMORPHIC AND IGNEOUS. (Archæan?)** Granite and Gneiss, Gneissic granite and syenite Micaceous hornblendic siliceous and argillaceous schists and slates Crystalline limestone, sandstone, quartzite, epidosite etc With dykes of granite, felsite, pegmatite, Diorite etc

H.Y.L. Brown
Gov't Geologist
31-10-96

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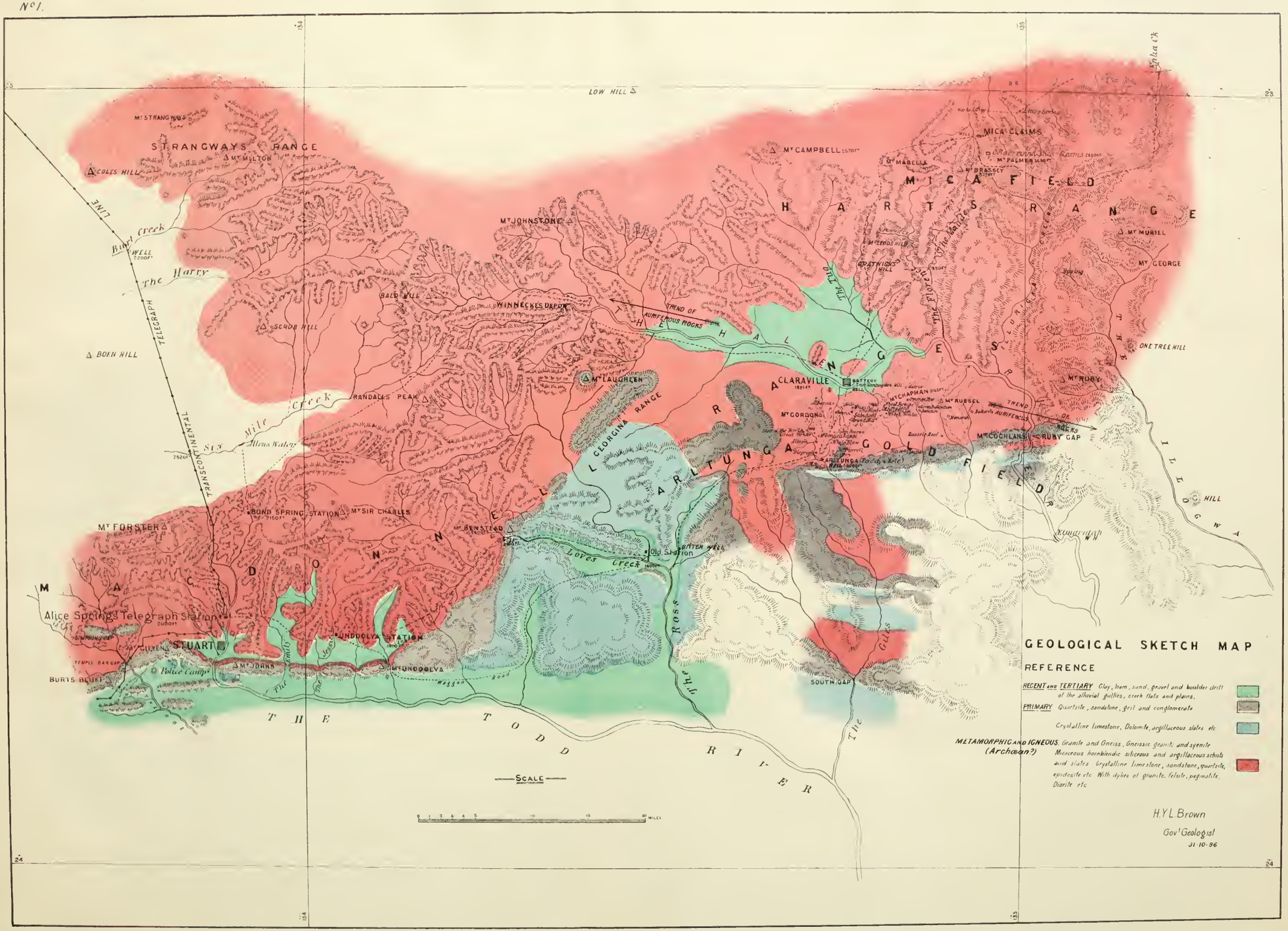


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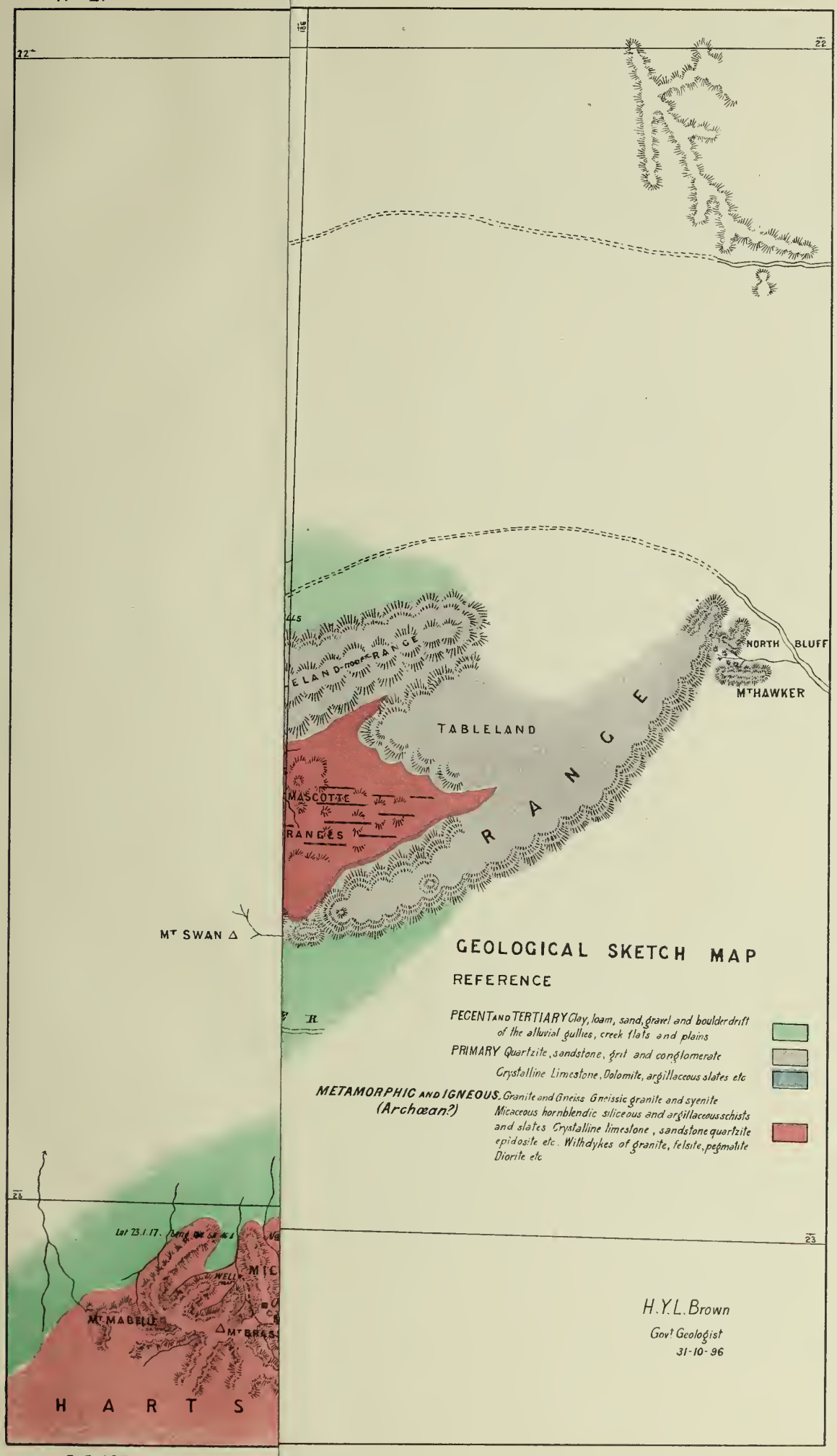
22°
22
ELAND-HOOF RANGE
NORTH BLUFF
MtHAWKER
TABLELAND
MASCOTTE
RANGES
RANGE
MT SWAN Δ
GEOLOGICAL SKETCH MAP
REFERENCE
PECENT AND TERTIARY Clay, loam, sand, gravel and boulder drift of the alluvial gullies, creek flats and plains
PRIMARY Quartzite, sandstone, grit and conglomerate
Crystalline Limestone, Dolomite, argillaceous slates etc
METAMORPHIC AND IGNEOUS. (Archœan?) Granite and Gneiss Gneissic granite and syenite Micaceous hornblendic siliceous and argillaceous schists and slates Crystalline limestone, sandstone quartzite epidosite etc. Withdykes of granite, felsite, pegmatite Diorite etc
H.Y.L. Brown
Govt Geologist
31-10-96
23
HARTS

P.P. 127. 2.

No 2.

## GEOLOGICAL SKETCH MAP

REFERENCE

PECENT AND TERTIARY. Clay, loam, sand, gravel and boulder drift of the alluvial gullies, creek flats and plains

PRIMARY. Quartzite, sandstone, grit and conglomerate

Crystalline Limestone, Dolomite, argillaceous slates etc

METAMORPHIC AND IGNEOUS. (Archæan?) Granite and Gneiss Gnrissic granite and syenite Micaceous hornblendic siliceous and argillaceous schists and slates Crystalline limestone, sandstone quartzite epidosite etc Wilthdykes of granite, felsite, pegmatite Diorite etc.

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Govt Geologist
31-10-96

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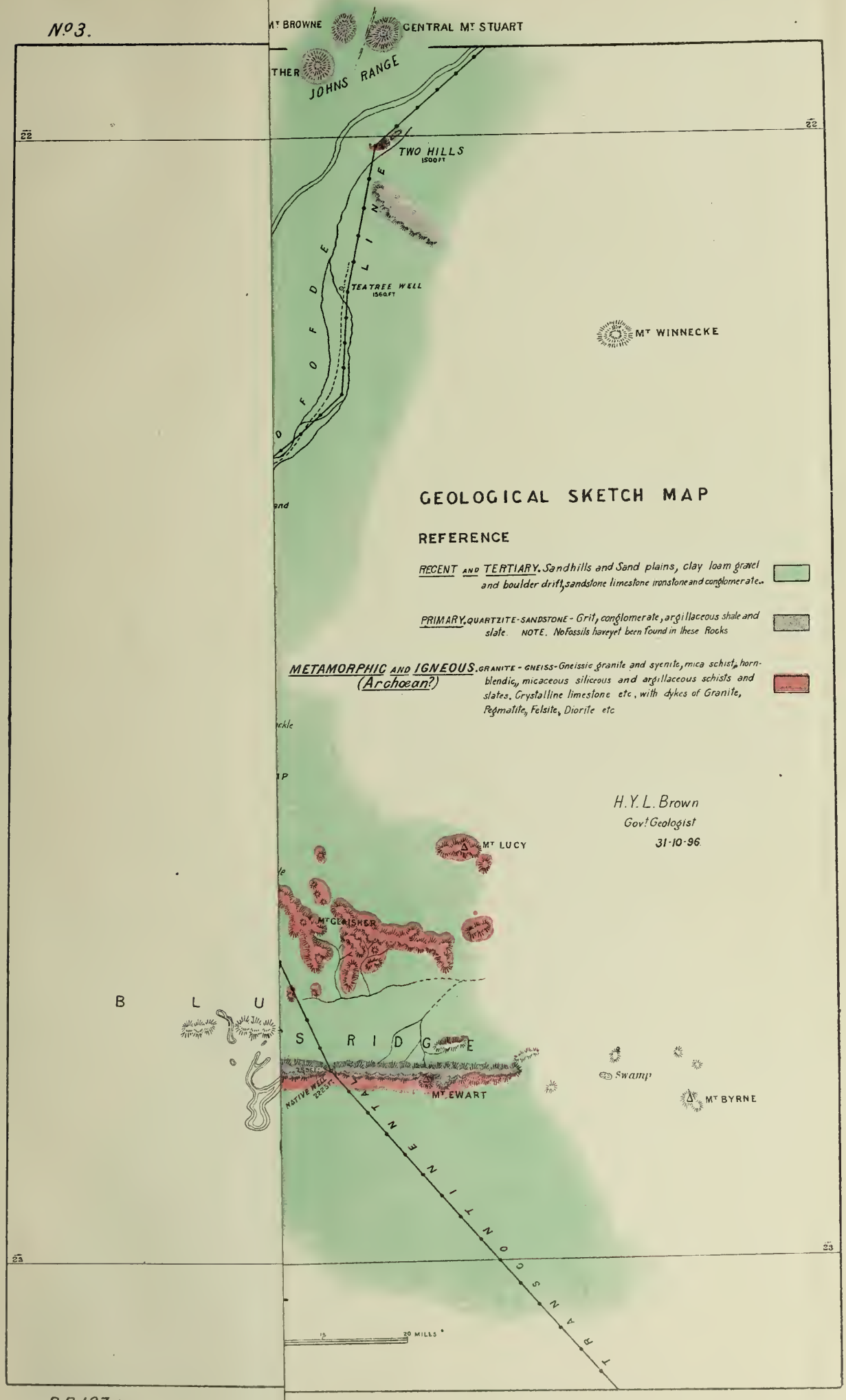
Mt BROWNE
CENTRAL Mt STUART
THER
JOHNS RANGE
22
22
TWO HILLS
1500 FT
TEATREE WELL
156 0 FT
Mt WINNECKE
GEOLOGICAL SKETCH MAP
REFERENCE
RECENT AND TERTIARY. Sandhills and Sand plains, clay loam gravel and boulder drift, sandstone limestone ironstone and conglomerate..
PRIMARY. QUARTZITE-SANDSTONE - Grit, conglomerate, argillaceous shale and slate. NOTE. No fossils have yet been found in these Rocks
METAMORPHIC AND IGNEOUS. (Archoean?)
GRANITE - GNEISS - Gneissic granite and syenite, mica schist, hornblendic, micaceous siliceous and argillaceous schists and slates. Crystalline limestone etc, with dykes of Granite, Pegmatite, Felsite, Diorite etc
H.Y.L. Brown
Gov't Geologist
31-10-96.
Mt LUCY
Mt GLASHER
B L U
S R I D G E
Swamp
Mt BYRNE
Mt EWART
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20 MILLS

P.P. 127.3.

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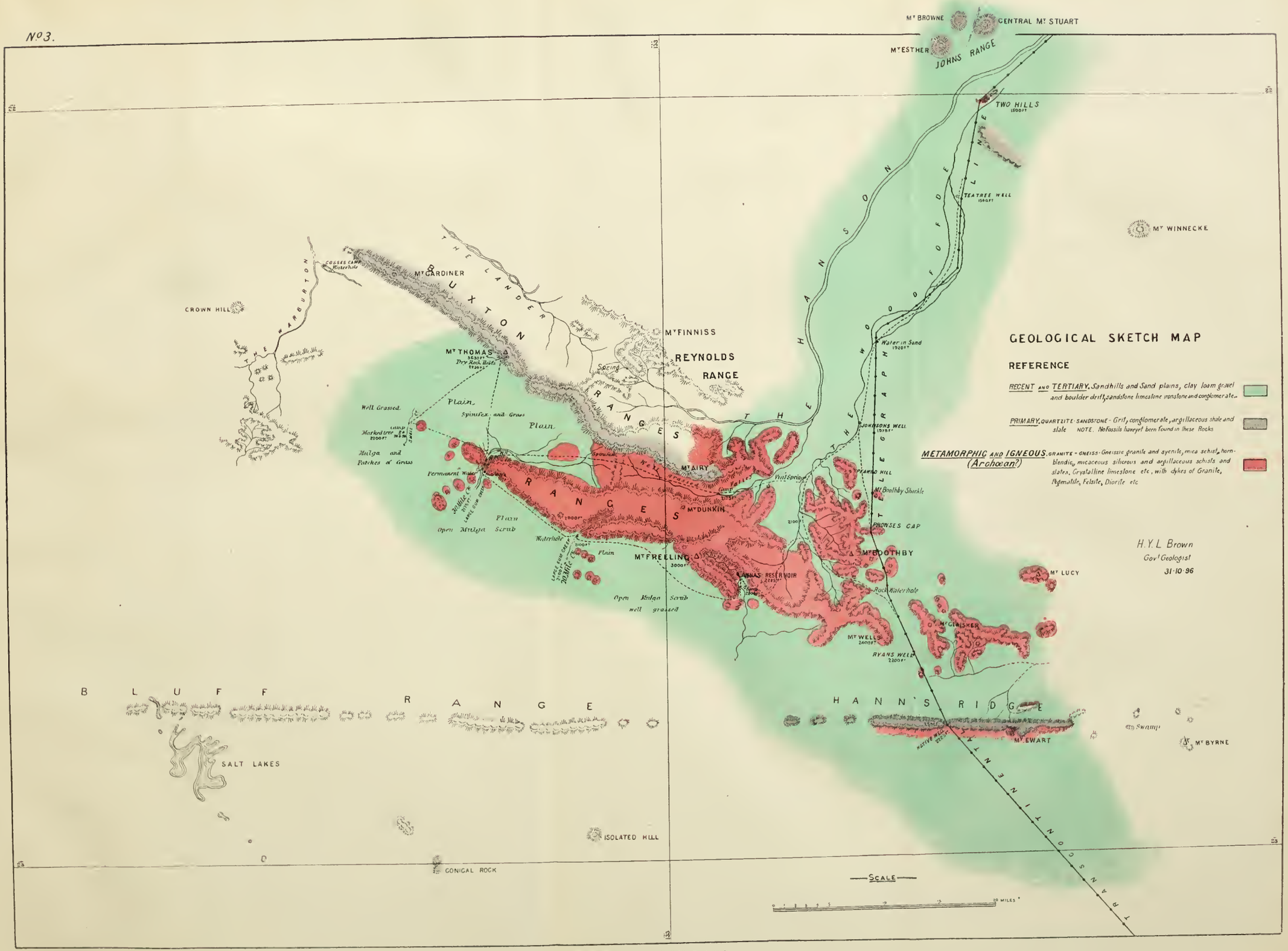


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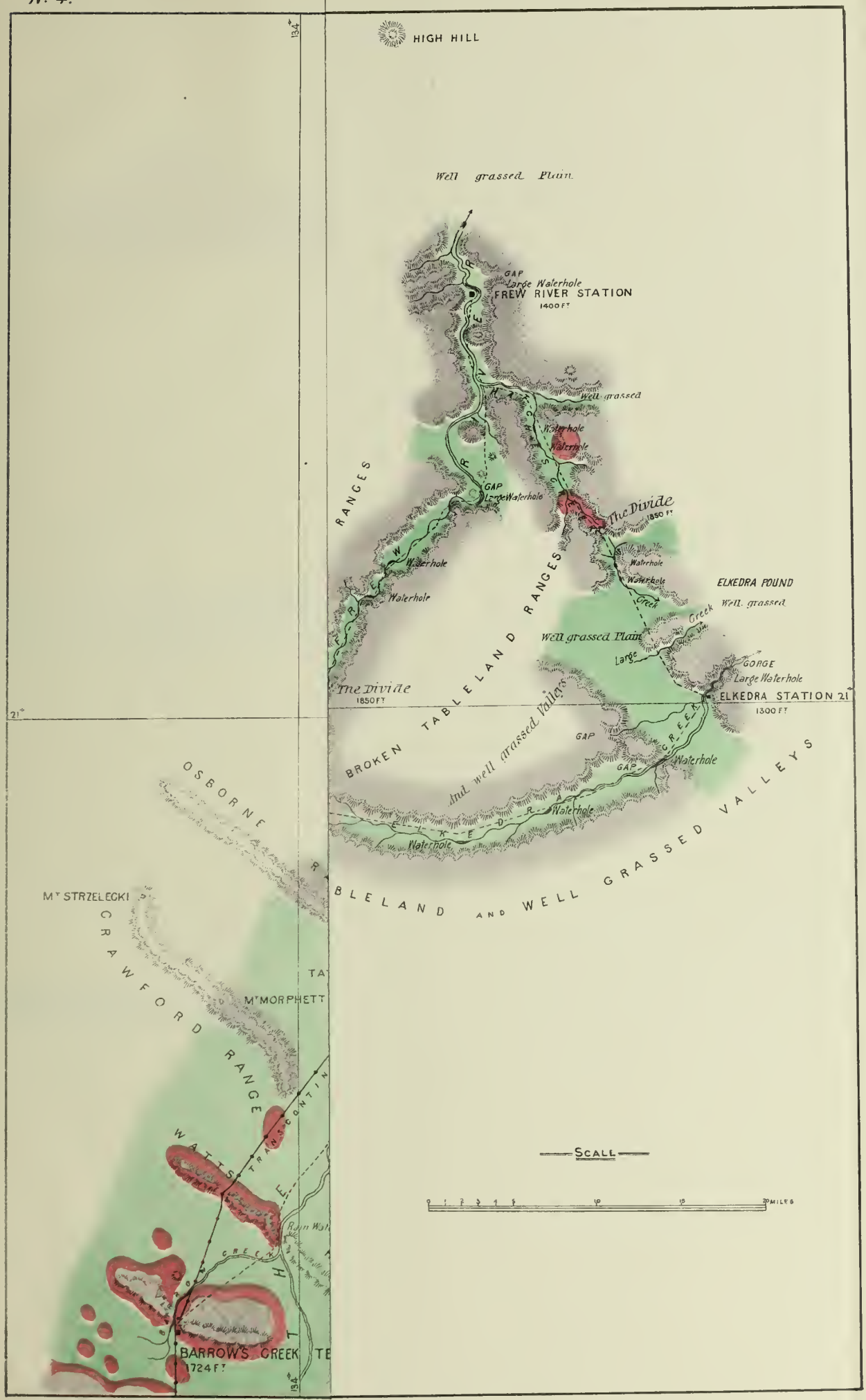


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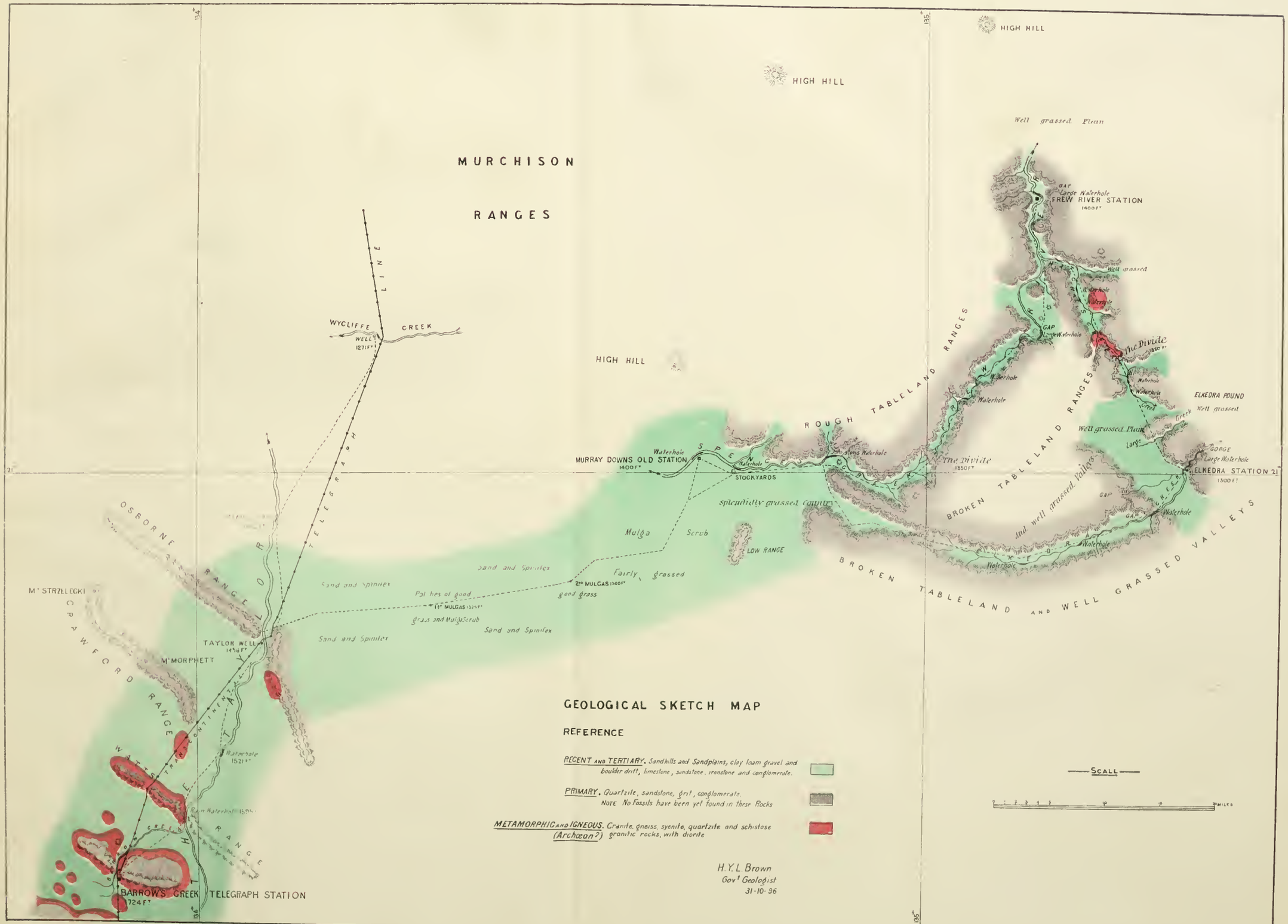


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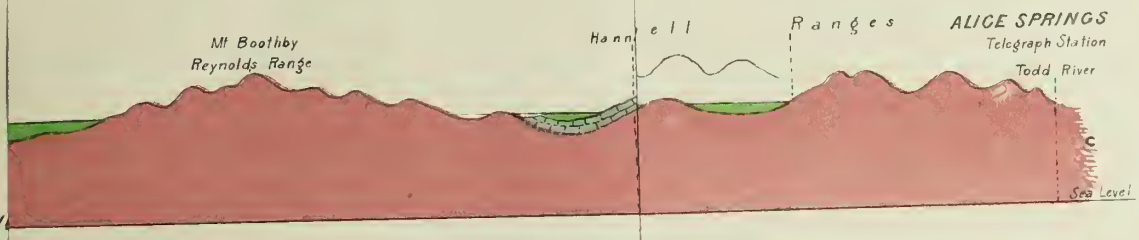
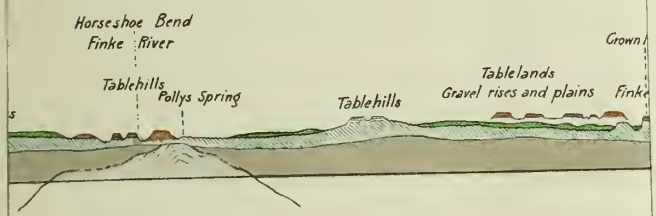
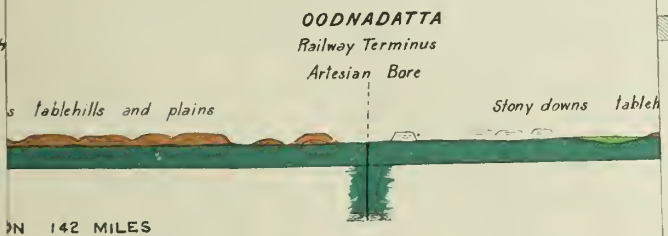
## SECTION




NGS – 197 MILES –




TE WATERS – 175 MILES –




ON 142 MILES

### SECONDARY.

**LOWER CRETACEOUS—**
Gypseous clays, marls, and blue shales, with limestone, ironstone, and sandstone bands.

**JURASSIC?—**
Argillaceous, micaceous, and calcareous sandstones, limestone and quartzite often falsebedded, and conglomeratic in places (containing pebbles and boulders of quartz, quartzite, granite, &c.)

ONTAL SCALE 8 MILES TO ONE INCH

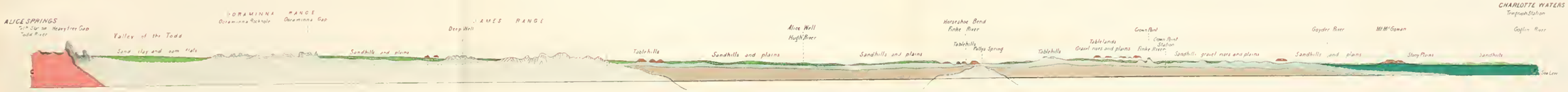
H.Y.L. Brown

Govt Geologist

31/10/96.

# GEOLOGICAL SKETCH SECTION

OSBORNE RANGE TO ALICE SPRINGS – 197 MILES –




ALICE SPRINGS TO CHARLOTTE WATERS – 175 MILES –

CHARLOTTE WATERS TO Mt DUTTON 142 MILES

VERTICAL SCALE 4000 FEET TO ONE INCH

HORIZONTAL SCALE 8 MILES TO ONE INCH

## TERTIARY.

RECENT and TERTIARY
Sand, clay loam, gravel, marl, travertine limestone, conglomerate, &c of the creek flats, plains, and sandhill country.

TERTIARY —
Quartzite, jasper rock porcelainite, breccia, conglomerate, sandstone, and white argillaceous and siliceous shales.

## SECONDARY.

LOWER CRETACEOUS—
Gypseous clays, marls, and blue shales, with limestone ironstone, and sandstone bands.

JURASSIC?—
Argillaceous, micaceous, and calcareous sandstones, limestone and quartzite often falsebedded, and conglomeratic in places containing pebbles and boulders of quartz, quartzite, granite, &c.)

## PRIMARY.

LOWER SILURIAN—
Reddish and pale colored sandstone micaceous sandstone and shale; the apparent extension of the Temple Downs series.

CAMBRIAN —
Quartzites, grit, conglomerate, &c., Siliceous pebble and grit, conglomerates, quartzites, sandstones, slates, dolomitic limestones, &c.

METAMORPHIC and IGNEOUS—(ARCHÆAN ?)—
Granite, gneiss syenite, &c.

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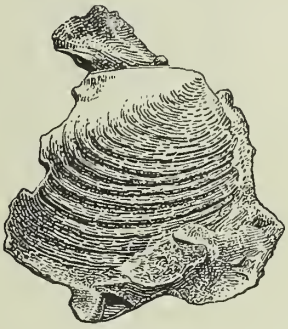

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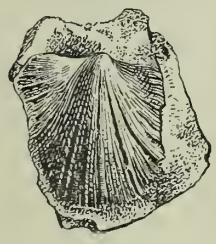

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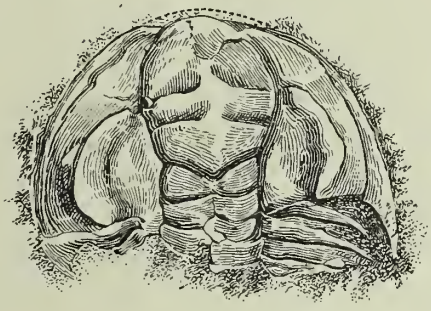

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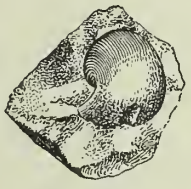

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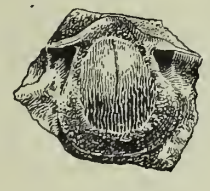

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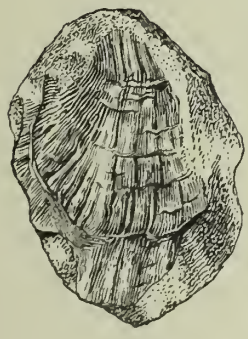

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Frank R Leggatt Del.
P.P.No 127. 6.

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